MACHINERY

DESIGN — CONSTRUCTION — OPERATION

Volume 38 APRIL, 1932 Number 8

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Total Distribution for March, 16,180 Copies

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PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS, 140-148 LAFAYETTE STREET, NEW YORK

ROBERT B. LUCHARS, President EDGAR A. BECKER, Vice-pres. and Treasurer ERIK OBERG, Editor FRANKLIN D. JONES, Associate Editor
CHARLES O. HERB, FREEMAN C. DUSTON and JOSEPH E. FENNO, Assistant Editors
LONDON: 52-54 High Holborn PARIS: 15 Rue Bleue

YEARLY SUBSCRIPTION: United States and Canada, $3 (two years, $5); foreign countries, $6. Single copies, 35 cents.

Changes in address must be received by the fifteenth of the month to be effective for the forthcoming issue.
Send old as well as new address.

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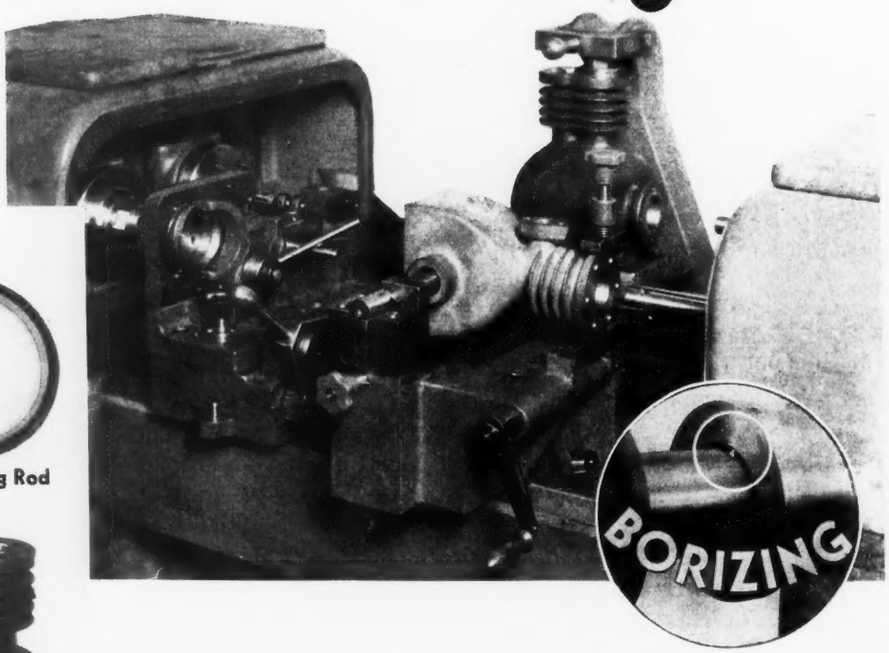
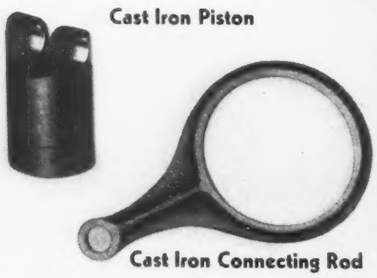
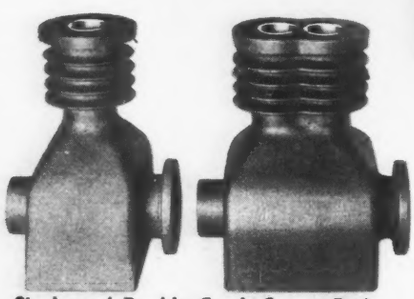
Variety of CAST IRON Parts Borized at One Setting!





Cast Iron Piston

Cast Iron Connecting Rod



Single and Double Crank Cases. Both cylinders and shaft holes were borized.

Borized parts such as illustrated in the above panel are absolutely interchangeable for accuracy, alignment and location of holes. They often check to better than the required tolerances and thus the fits are perfect. So consistent are the results that only periodic inspection is necessary. Thus, by eliminating scrap and all reamer expense the net cost is very much reduced.

THERE is a continued marked success in the borizing (the newer method of boring with a diamond or tungsten carbide tool) of cast iron with the Heald Bore-Matic.

One of the recent installations is shown above where various refrigerator parts, consisting of the cylinder and shaft hole of the crank case, both ends of the connecting rod, and the piston, were borized in a single set-up.

If you are finishing holes in non-ferrous metals or cast iron, you should have full information about this newer method, the tools and the machine, which will be sent on request.

The Heald Machine Company, Worcester, Massachusetts, U. S. A.

Branch Offices at Chicago, Cleveland, Detroit, New York and Philadelphia

HEALD

MACHINERY

Volume 38 NEW YORK, APRIL, 1932 Number 8

Rubber

A New Material in Machine Design

New Developments in the Application of Rubber Open up a Broad Field for this Material in Machine Construction

Mountings to Absorb Vibration are Now Very Widely Used, Covering a Range from Radio Sets to Automobiles

WHILE rubber has achieved the distinction of being one of the more important materials used in industry, only recently has it found a thoroughly practical application in machine design. It has been used now and then for special purposes, but as a recognized component part of machine assemblies, it may well be classed as a new material. However, great strides have been made during the last few years in making rubber applicable for many purposes in machine design, especially where vibration-absorbing mountings are required.

In the work of adapting rubber to machine design purposes, the Lord Mfg. Co. of Erie, Pa., has played an important part. This company has developed methods whereby shock- and vibration-absorbing mountings can be made in the form of either tubular or flat members. The tubular members are constructed of an outer steel bushing and an inner steel bushing or solid pin, with rubber filling the space between the two members. The rubber is vulcanized directly to the metal parts so that it is integral with them. The shock- and vibration-absorbing mountings may also consist of two flat plates with rubber between them, vulcanized directly to the plates. The general arrangement of the tubular-shaped mountings is illustrated in Fig. 1.

An important point in connection with these mountings is the fact that, when the rubber cools from the vulcanizing temperature to ordinary room temperature, it contracts and becomes subject to a severe initial tension. Hence, when loads are applied radially, for example, this tension makes the entire bushing carry the load, rather than only that part which is directly below the load-carrying shaft. Further, when the load is applied axially, the rubber is subjected to tension and shear stresses. It is generally conceded that a shear and tension suspension is more efficient for the absorption of vibration than a compression pad.

Mountings having initial tension are very sensitive to the action of small forces, but become stiffer in proportion to the size of the movement. The shear distortion of the rubber provides a suspension without excessive movement and with no metallic connection. The bonded construction makes a compact unit which is suitable for many different uses. Vibration-absorbing mountings are now made in designs small enough for a radio tube and big enough for large Diesel-electric units. The method of application can be best explained by a number of examples of typical mountings.

Fig. 1 shows the type of mounting used for air compressors, motor-generators, and similar equipment where the movement under shock load does not have to be kept to very close limits. As will be noted, the outer sleeve is pressed into a bracket with a lip or projection at the lower edge. The bolt is provided with a large head or a washer at its upper end. A similar support, used for a motor-generator set, is shown in Fig. 2. Mountings of this type are widely used.

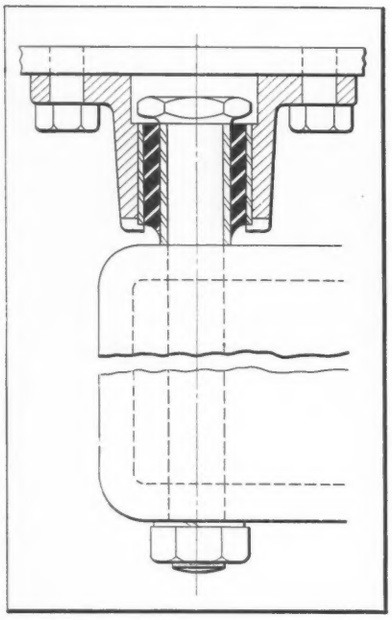


Fig. 1. Design of Rubber Mounting Used for Air Compressor

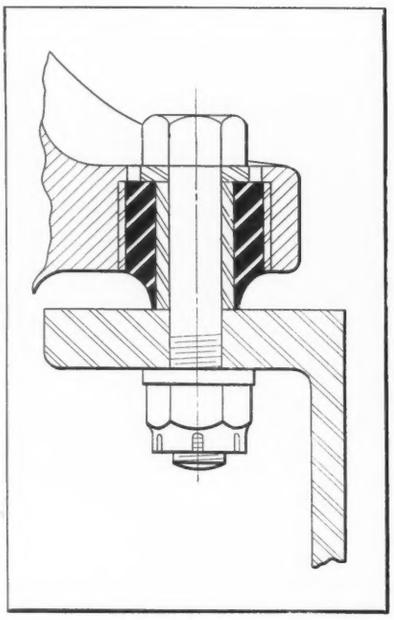


Fig. 2. Design of Mounting Employed for Motor-generator Set

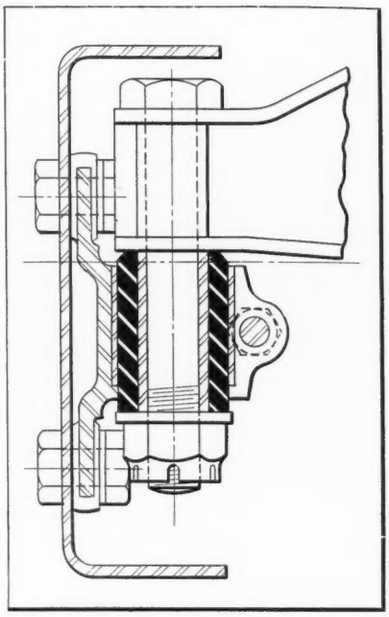


Fig. 3. Holding Movements under Overloads to Close Limits

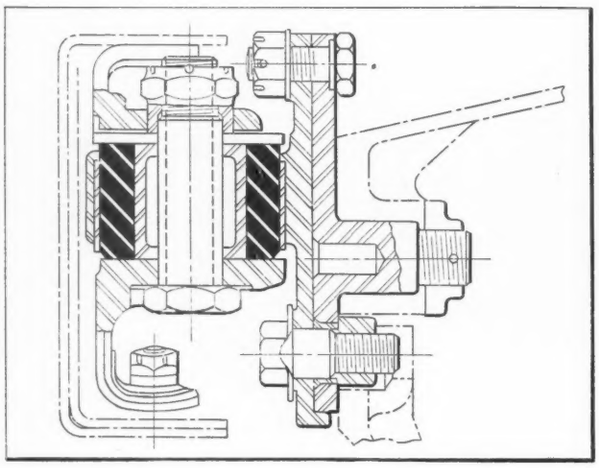


Fig. 4. Another Mounting Like that Shown in Fig. 3

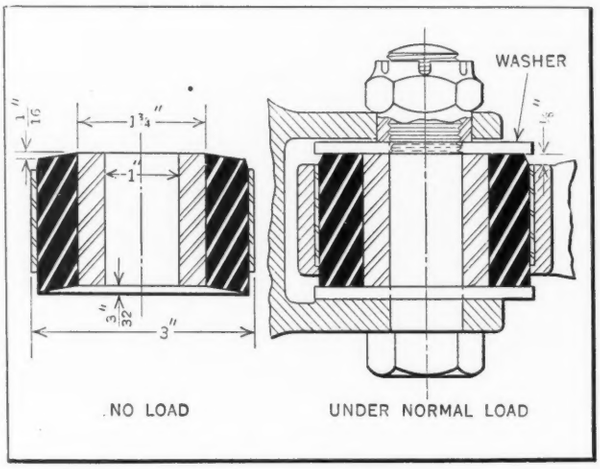


Fig. 5. Two Cones Form the Load End of the Mounting

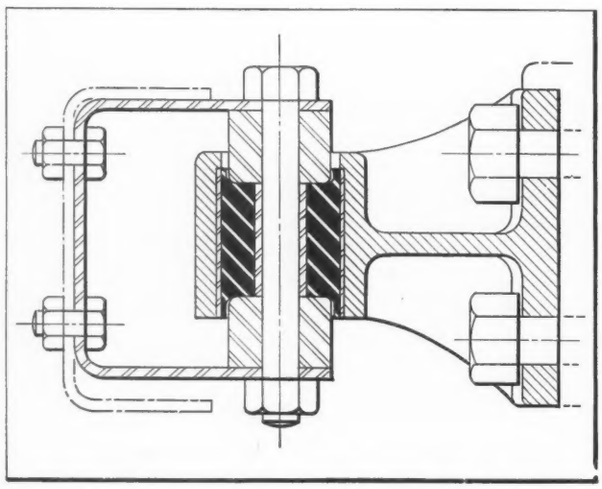


Fig. 6. A Construction to Restrict Radial Movement

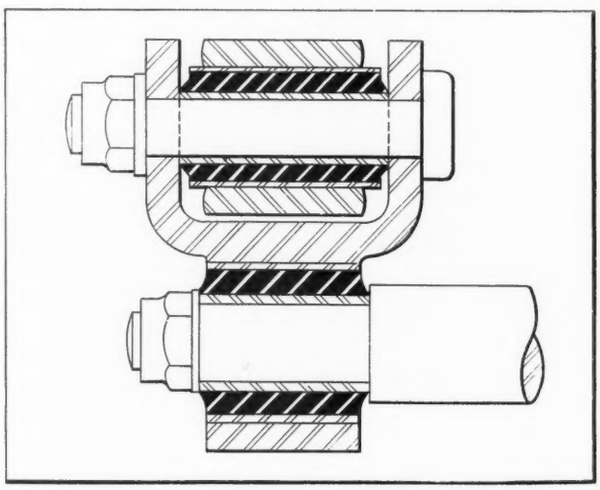
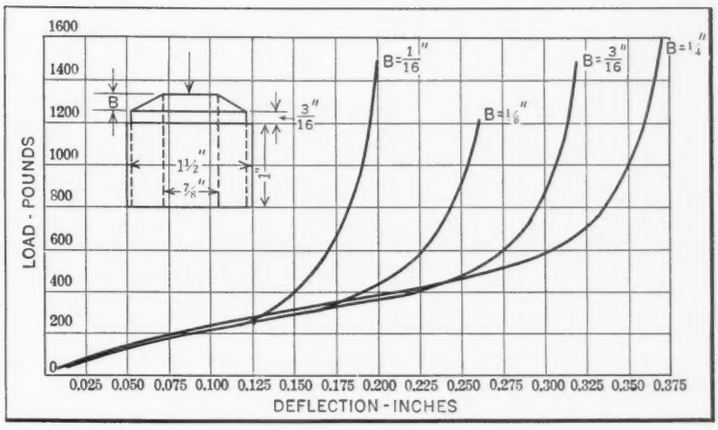


Fig. 7. Typical Spring Shackle Joint Design

Fig. 8. Diagram Showing the Relation of Load to Deflection of Rubber Extensions on Mountings Such as Shown in Fig. 5



When it is necessary to keep the movement under overloads to very close limits, the types shown in Figs. 3, 4, and 5 are used. When these mountings are employed, the load-deflection curve has a pronounced curvature—that is, the mounting is soft for a limited range and then it stiffens up rapidly. This effect is obtained by forming the load end of the rubber mounting by two cones, as shown to the left in Fig. 5. As the load is applied, the mounting is soft up to the time that the flat washer across the end of the mounting touches the second or steeper bevel, as indicated at the right in Fig. 5. When the washer reaches this point, the rubber is locally compressed and induces a tensile stress in the outer shell bond at the end of the mounting. This is illustrated by the curves in Figs. 8 and 11, which show the relation of load, in pounds, to deflection, in inches, for different bevels.

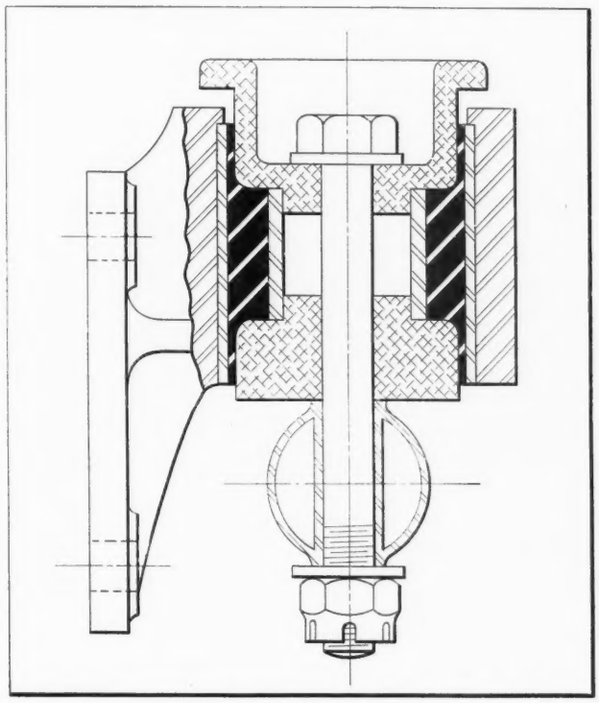


Fig. 9. A Variation of the Mounting Shown in Fig. 6 to Restrict Radial Movement

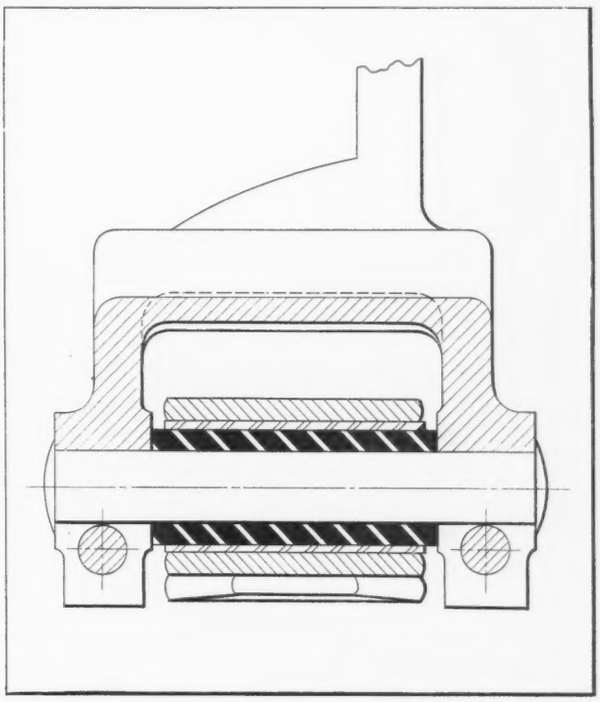


Fig. 10. Typical Design for Joint for Limited Oscillating Movement

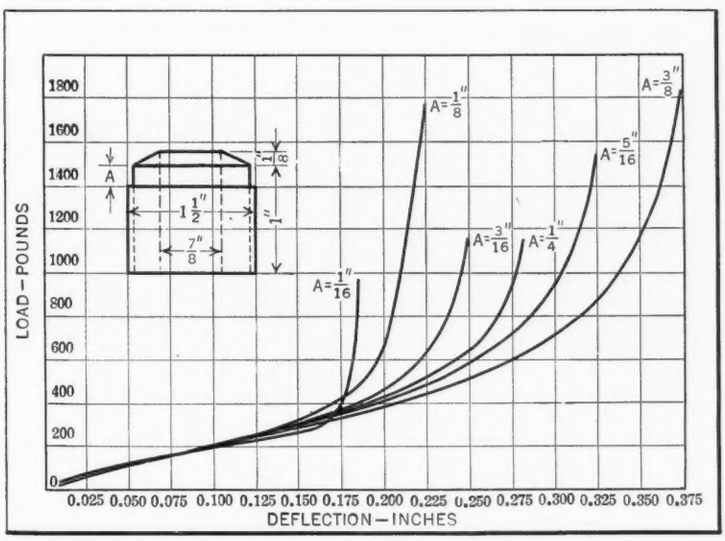


Fig. 11. Diagram Showing Same Relations as in Fig. 8 for Different Dimensions of Rubber Extensions on Mountings

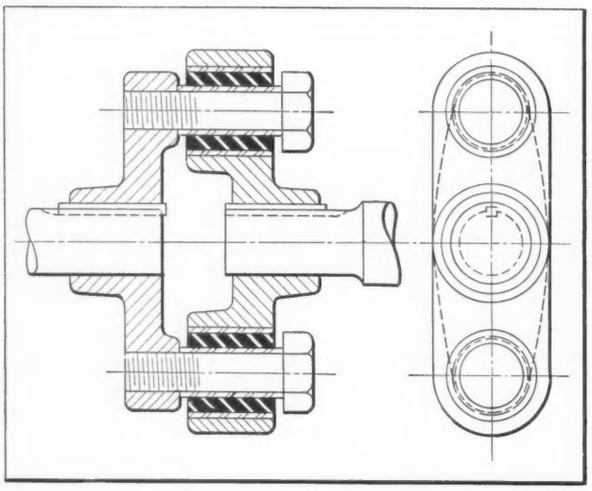


Fig. 12. Rubber Bushings Employed in Couplings

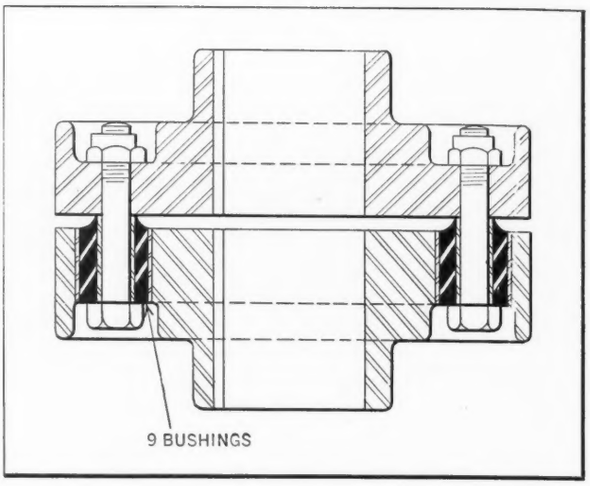


Fig. 13. Another Coupling Design with Rubber Bushings

The unloaded end of the mounting is also made concave, so that under normal load, both ends of the mounting may become flat, with the result that, as mentioned, the mounting is soft for a limited range in either direction and then "snubs" very rapidly.

Figs. 6 and 9 show a further development of this type of mounting. Here the outer shell is extended and lined with rubber, while end plugs replace the end washers. This construction permits of radial control. The free movement of the component parts is restricted in every direction.

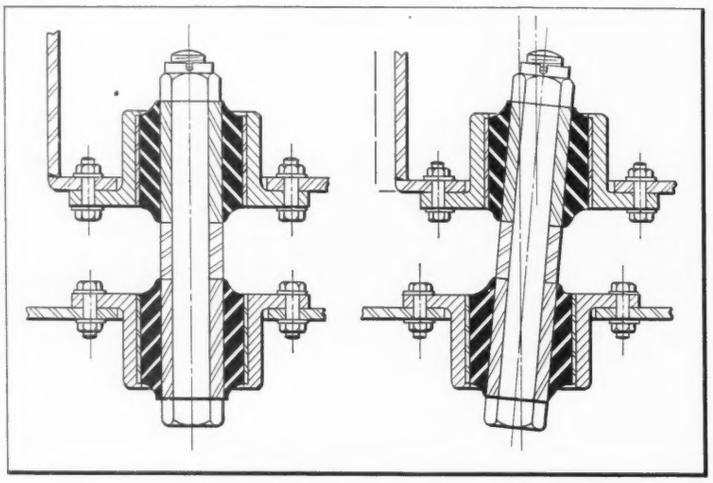


Fig. 14. A Mounting that Permits Large Movements Both Sidewise and Vertically

Figs. 7 and 10 show typical installations of vibration-absorbing designs for such purposes as spring shackle joints, torque and brake-arm joints, and other purposes where there is a limited oscillating movement. Because of the initial tension in the rubber, not only the rubber under the projected area of the center stud or shaft, but all the rubber surrounding the inner bushing aids in carrying the load. Hence, a joint of comparatively small size has great carrying capacity and long life.

Designs involving the use of rubber bushings for couplings are shown in Figs. 12 and 13. Because of the bonded construction and the inherent initial tension in the rubber, the load-carrying capacity of the rubber members is unusually high and the life is correspondingly long.

An interesting design of flexible coupling used for a fractional-horsepower motor—1/4 horsepower or less—is shown in Fig. 15. Fig. 16 shows a different arrangement used for a "fifth wheel"

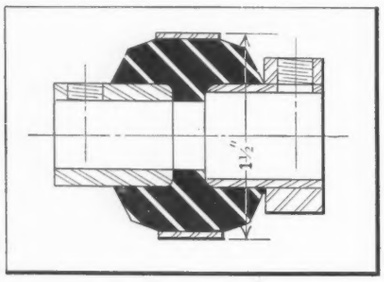


Fig. 15. A Flexible Coupling for Light Drives

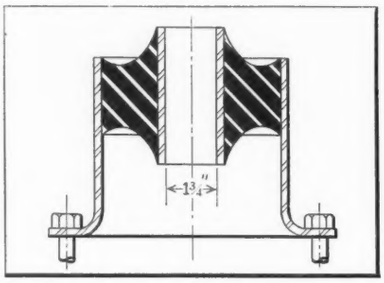


Fig. 16. A "Fifth Wheel" Coupling for Semi-trailers

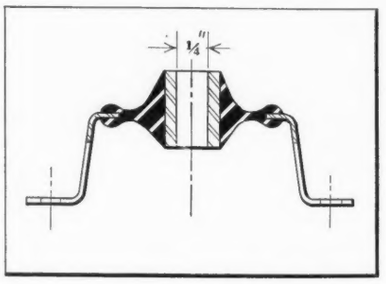


Fig. 17. A Sensitive Mounting for Instruments

coupling for semi-trailers. Here considerable flexibility is possible and the rubber mounting accommodates quite large movements caused by uneven road conditions.

A few special applications may also prove of interest. Fig. 17 shows a very sensitive type of mounting for absorbing vibration in instruments, radio assemblies, and similar apparatus. Fig. 14 shows a case where a very soft mounting was required to care for both sidewise and vertical movements. The length of the bushing used in the middle between the top and bottom members determines the amount of sidewise movement possible.

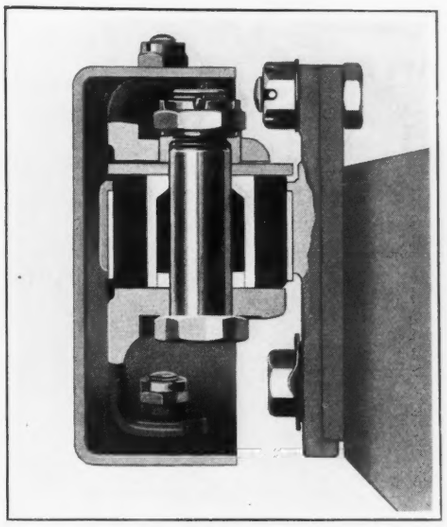


Fig. 18. Rubber Mounting as Applied to a High-grade Automobile

The application of rubber mountings is constantly broadening. Most of the automobile manufacturers now use rubber mountings for supporting the engines and also for spring-shackle joints, radiator and muffler supports, as well as for body supports and "midship" bearing supports on buses and trucks. On airplanes, delicate instruments are mounted in rubber bearings to save them from destructive shocks when landing.

The mountings can be arranged to support the load from above or the load can be hung from the mounting. Two mountings can also be used, if required, to obtain double the movement possible with one mounting. Variations in the shock-resisting qualities of these mountings can be made by varying the quality of the rubber used and by increasing the diameter of the central member. It is obvious that by either or both of these means it is possible to vary the rate of movement of the load.

Uniformity in the rubber used for mountings is an important factor in obtaining satisfactory results. Carefully established laboratory methods for testing, both before and after vulcanizing, are necessary. Only by such careful manufacturing control methods can the required uniformity be secured.

Leather Belting is Now Sold by Thickness

The American Leather Belting Association has decided that, for the greater protection of the consumers of leather belting, it should establish and sell this commodity by specifications of thickness instead of weight, thereby discarding the old weight terminology of "ounces per square foot," which may be varied by merely adding weighting materials to the leather, and does not always represent a differential in transmission values. This decision was reached after the Association had canvassed all manufacturers of belting throughout the country, with the result that eighty-one replies were received, all voting for the change. Therefore, according to the Association, the movement can be considered as having the endorsement of the entire industry.

Inasmuch as leather belting prices are based on thickness, this change makes for simplicity. It makes comparatively easy the checking of each piece of belting, to see if the average thickness is as ordered.

The thickness specifications now in effect for first-quality leather belting are as follows:

Medium Single .....10/64 to 12/64 inch;
Heavy Single .....12/64 to 14/64 inch;
Light Double .....15/64 to 17/64 inch;
Medium Double .....18/64 to 20/64 inch; and
Heavy Double .....21/64 to 23/64 inch.

1. All thicknesses in the table are average thicknesses, in inches, and should be determined by measuring twenty coils and dividing this value by the number of coils measured. In rolls of belting containing less than twenty coils, the average thickness should be determined by measuring one-half the total number of coils and dividing this value by the number of coils measured.

2. The classification of "light single" has been eliminated entirely.

3. No point in either single or double belting shall be more than 2/64 inch thicker nor more than 2/64 inch thinner than the average thickness.

4. The second and third quality brands of each manufacturer bear the same relative thickness to the manufacturer's first quality grades as they did in the past under the old ounces per square foot specification.

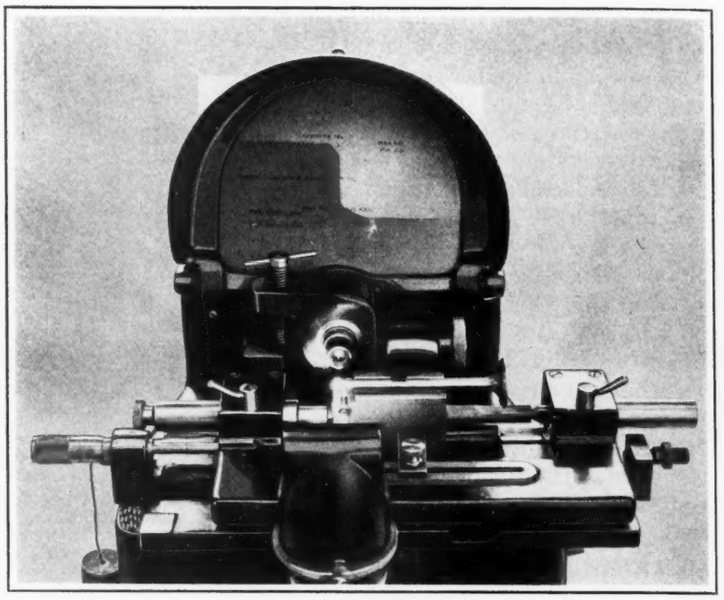
These thicknesses are now in effect and the Association recommends that they be used by all buyers of belting in wording their orders. Every order for "single" or "double" should specify the thickness on the order. If just the words "light," "medium," or "heavy" appear on the order, these words now mean the thickness as given in the table and not the weight, as formerly.

Users of leather belting will find it of advantage to take note of these new specifications.

Rapid Inspection with an Optical Projector

A Method of Visual Inspection that has Proved Very Successful in Several Automotive Valve Manufacturing Plants

By H. T. LAFFIN



AUTOMOTIVE poppet valves have always presented a serious gaging problem, because of the fact that they are manufactured in large quantities and, at the same time, must be held to precision limits. The diameter of the stem, the angle of the seat, and the concentricity of the seat with the stem are important measurements that must be checked, as are also the over-all length and the recess near the end of the stem. Most methods used for checking these dimensions consume much time and give no positive assurance of accuracy.

This article deals with a method of visual inspection that has proved very satisfactory in the shops of large manufacturers of automotive valves. The optical projector employed is the Jones & Lamson comparator. The measurements taken with this machine are first, the diameter of the stem at *A*, Fig. 1; and second, the seat angle *B*, the concentricity of seat *C*, and the over-all length *D*. The important dimensions of the recess indicated in Fig. 2 are also checked.

The comparator is equipped with a fixture having 60-degree vees that accurately locate the stem in front of the lens, as shown in Fig. 3, for inspecting the diameter. A chart is used on which lines are spaced to show the maximum and minimum prescribed limits of diameter variation. The magnification on the chart is 135 to 1. Each 0.001 inch variation is magnified to slightly over 1/8 inch.

The machine is set up by placing a maximum-diameter master plug in the fixture before the lens and adjusting its shadow to coincide with the upper tolerance line on the chart. The lower line represents the minimum acceptable diameter. The master is then removed and replaced by the valves to be tested. The valves are located in the fixture so that a portion of the stem near the head of the valve comes in front of the lens. The stem is then drawn through the vees to see if the shadow cast by the entire length remains inside the outlines on the chart.

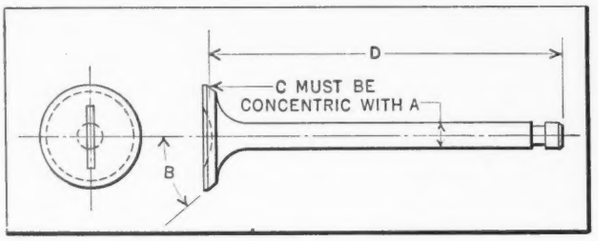


Fig. 1. Diagram Indicating Elements of Valve Checked by Optical Projector

The master is occasionally placed in the fixture to check the adjustment of the machine. The checking of the valves is performed at the rate of 1000 valves per hour. Fig. 4 shows how the comparator is used for inspecting angle *B*, Fig. 1, the concentricity of the seat, and the over-all length *D* from the seat to the end of the stem. For this work, a V-block is so mounted on the comparator table that it brings the axis of the valve in the proper position before the lens. The block carries an adjustable stop against which the end of the stem rests.

A motor for rotating the valve is fastened to the end of the table, as shown. This motor operates a rubber driver which comes in contact with the head of the valve. The tolerance chart on which the shadow is projected is made up of a basic line 0–0 and a series of lines on each side, drawn parallel to it and spaced a distance apart equal to the allowable run-out of the seat with the stem. A sufficient number of spaces or tolerance zones is provided to cover the allowable variation in the length *D*, Fig. 1. The lines on the chart are drawn parallel with the shadow of the seat of an accurate valve.

The comparator is set up by placing a valve of the correct dimensions in the fixture and adjusting the seat before the lens so that it casts a shadow on the basic line 0–0 of the chart. The shadow is adjusted to the basic line to represent a valve of the correct length. The motor

is then started and the shadow of the master remains constant on the basic line. The master is now replaced by the valves to be tested and their shadows compared with the master represented by the basic line on the chart.

If the shadow staggers more than the width of a tolerance division on the chart or if the shadow of the angle *B* fails to parallel the lines on the chart, the valve does not pass inspection. If the shadow falls outside of the series of tolerance lines, it is too long or too short, depending upon whether it falls to the right or the left of the lines.

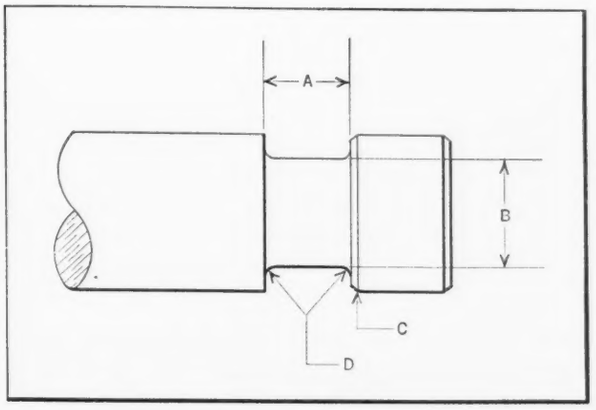


Fig. 2. Valve Stem Recess Checked by Equipment Shown in the Heading Illustration

Inspection of the dimensions *A*, *B*, *C*, and *D*, Fig. 2, of the recess near the end of the stem is accomplished on the comparator equipped with a fixture consisting of a base and carriage, as shown in the heading illustration. The base is provided with an adjustable stop at the right-hand end and a micrometer at the left. A V-block fixture is held between the centers of the carriage. At the left end of the fixture, in line with the V-block, there is a stop for locating the valve laterally. The valve is mounted in the V-block with the right side of the recess located against this stop, and the micrometer is then set at zero.

The adjustable stop at the opposite end is next brought against its anvil to eliminate lateral movement of the carriage. The shadow of the left side of the recess is adjusted to coincide with the basic vertical line on the chart, while the shadow of the bottom of the recess is made to coincide with the maximum groove diameter. The shadow of the outside stem diameter is made to coincide with the maximum outside diameter tolerance line. If radius *D* and chamfer *C*, Fig. 2, are correct, their shadows will match the enlarged outline on the chart.

When the machine is lined up in this manner, the micrometer is backed away an amount equal to the specified width of the valve recess, and the dimensions of the opposite side of the groove are checked. The machine now being in adjustment, the valves are placed in the fixture and the required measurements are taken by moving the carriage between the anvils. The chart shown in the heading illustration is drawn up with lines showing the allowable tolerances on all four dimensions of the recess.

Those who are familiar with previous methods of poppet valve inspection will readily recognize the rapidity, convenience, and accuracy of the optical method here described.

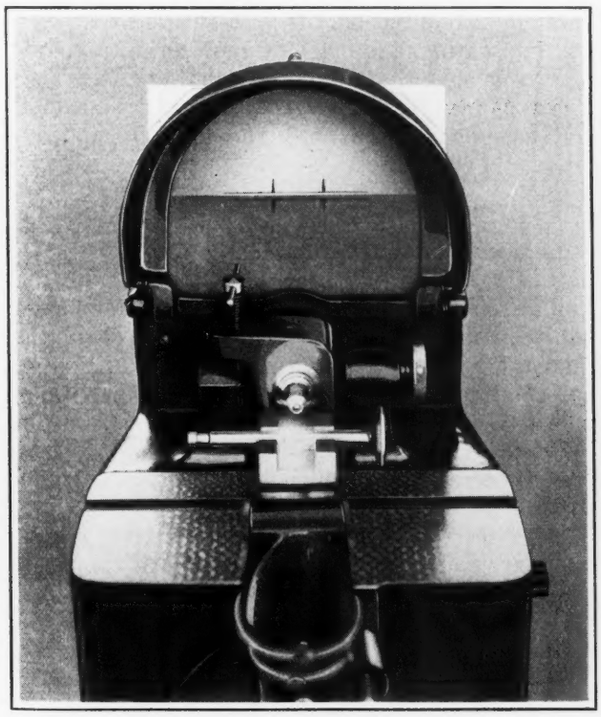


Fig. 3. Comparator Equipped for Checking Valve Stem Diameters

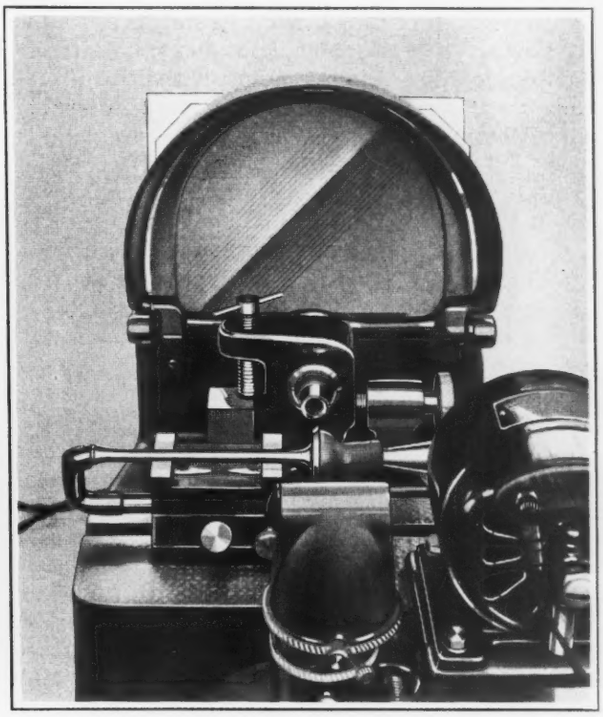


Fig. 4. Checking Concentricity, Length, and Angle of Valve

The Use of Light-Weight Magnesium Alloys

A Review of the Development of Commercial Magnesium-Base Alloys Having a Specific Gravity of Less Than One-Fourth that of Steel

By Dr. JOHN A. GANN
The Dow Chemical Co., Midland, Mich.

MAGNESIUM alloys are rapidly gaining industrial prominence because of their extreme lightness and good physical and mechanical properties. In 1929, the consumption of magnesium was nearly 1,000,000 pounds.

Magnesium alloys, because of their lightness, combined with strength and toughness, are particularly well adapted for use in portable hand-operated equipment and high-speed reciprocating parts of machinery, as well as in the automotive and aircraft industries. They are used successfully for impellers and blades of high-speed fans, and should be considered wherever inertia and centrifugal forces are to be dealt with.

At present, the automobile industry, particularly on the European continent, is making extensive use of magnesium-alloy castings in engine and transmission parts. In one instance, the use of this alloy resulted in a net saving in weight of 220 pounds. A still greater saving was found possible in motor coaches, where 520 pounds was saved in the set of wheels alone. This also improved the operating efficiency and riding qualities, and increased the tire life 63 per cent (this represents the maximum increase in tire life and not the average).

The more important applications thus far made in the airplane industry include crankcases, housings, covers, fuel tanks, ribs, struts, wheels, sheet covering, furniture, and trimmings. A riveted magnesium-alloy wing section with rib profiles made from sheet metal, and acetylene-welded oil and gasoline tanks are typical successful applications. In 1927, magnesium constituted 10 per cent of the light metals used in German aircraft work, and in 1929, it amounted to 50 per cent.

At least ten or twelve leading manufacturers of aviation engines in this country are using magnesium-alloy parts. Crankcases, blower sections, starter housings, and hub-wheels are among the cast parts used, while propellers and nose-pieces are among the largest magnesium-alloy forgings thus far made.

Various types of magnesium-alloy propellers have passed the government whirling tests. One of these propellers, designed for a 225-horsepower engine, stood up under a load of 1600 horsepower. These propellers weighed 52 pounds, as compared with 78 pounds, the weight of similar propellers made of another light alloy. More than one hundred of the magnesium-alloy propellers are now in use. Acetylene and electric spot-welded magnesium-alloy motor coach chairs and gasoline tanks are other new developments. The series of Dowmetal alloys known as F, E, A, T, M, and G are typical of the magnesium alloys produced in this country. The properties of these different alloys were given in the Data Sheets published in December, 1931, MACHINERY.

For equal strength in bending, Dowmetal sheet is 1 1/2 times as thick, 40 per cent as heavy, and 90 per cent as stiff as steel sheet.

For equal weight, it is 4 1/2 times as thick, has 7 1/2 times the bending strength, and is 18 times as stiff as steel sheet.

For equal strength in bending, a Dowmetal beam is 40 per cent larger, 40 per cent as heavy, and 75 per cent as stiff as a steel beam of similar cross-section.

For equal weight, it has 3 1/2 times the bending strength, and is 4 times as stiff as a steel beam of similar cross-section.

Method of Casting Magnesium Alloys

In casting magnesium, a flux is used in the melting pot similar to the bath employed in the electrolytic cell for the production of the metal. This flux entirely surrounds the molten metal. A ladle with an under-feed spout is used in pouring, so that only clean metal enters the mold.

This flux has been developed to a point where it purifies the metal by a washing rather than a solvent action, so that the metal is free from non-metallic contamination. It is so efficient that foundry, fabrication, and machine shop scrap treated by it gives a melt that cannot be distinguished from virgin metal. This flux also permits continuous melting and casting as more metal can be added to a partially empty pot.

Heat-Treatment of Magnesium Alloys

Magnesium-alloy castings are used both in the "as cast" and in the heat-treated conditions, depending on the alloy composition and the service requirements. Dowmetal E castings are not heat-treated, while alloys containing more than 8 per cent of aluminum are susceptible to a wide range of heat-treating operations. For example, sand-cast Dowmetal A, without heat-treatment, has a tensile strength of about 26,000 pounds per square inch. Solution heat-treating at 750 degrees F. for four hours raises the tensile strength to 28,000 pounds per square inch, while twenty-four hours' treatment at the same temperature raises the tensile strength to 35,000 pounds per square inch. Continuing the treatment for ninety-six hours has no further effect on the tensile strength. Precipitation heat-treatment at 350 degrees F. for a period of twenty-four hours raises the tensile strength to 38,000 pounds per square inch.

Hot- and Cold-Working

The Dowmetals A, E, F, T and M lend themselves to most hot-working operations, which should preferably be performed at between 400 and 800 degrees F. A limited amount of cold-working is possible on the thoroughly worked and annealed metal, particularly when it is in the sheet form. Best results are obtained at moderate working speeds, as this gives the metal sufficient time to flow into its new shape. Press-forging, for example, is recommended rather than drop-forging, especially for the magnesium alloys having the higher percentages of aluminum, with correspondingly lower malleability.

Welding Magnesium Alloys

Commercial magnesium alloys can be joined satisfactorily either by acetylene fusion-welding or by pressure methods, such as electric spot- or seam-welding. The electric-arc methods have not been adapted to these alloys. Acetylene welding requires a suitable flux, but inert atmosphere and other special equipment are not needed. The welding technique differs slightly from that used with steel, chiefly because of the relatively low melting points of these alloys, but any good welder can make satisfactory magnesium-alloy welds after a few hours' practice.

Several commercial aluminum-welding fluxes have been found satisfactory. They are composed essentially of sodium, potassium, and lithium chlorides. Magnesium-alloy welding wire should be of approximately the same composition as the material being welded. Acetylene welds on magnesium-alloy sheets have a tensile strength of from 25,000 to 30,000 pounds per square inch.

Satisfactory electric spot-welds have been made on magnesium-alloy sheets up to 1/4 inch thick. Higher current densities are required than in the case of steel spot-welding, because of the higher electrical conductivity of magnesium alloys. The tensile strength per spot-weld on Dowmetal F sheets 1/32 inch thick is from 500 to 600 pounds; on 1/16-inch sheets, 900 to 1000 pounds; on 1/8-inch sheets, 1600 to 1900 pounds; and on 1/4-inch sheets, 1900 to 2200 pounds.

Practice in Making Riveted Joints

Riveted joints on magnesium-alloy sections can be made with rivets of approximately the same composition as the material joined. The rivets should be driven hot at a temperature between 572 and 752 degrees F., preferably by pressure or squeezing rather than by hammer blows. Standard 2S or 3S aluminum rivets can be used when hot-riveting is not feasible.

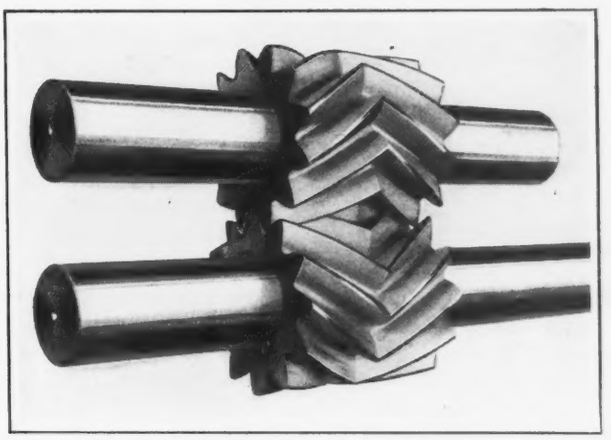
The design of the riveted joints, as with other metals, is based on the shear strength of the rivet and on the tensile strength and bearing strength of the sheet. The shear strength of magnesium-alloy rivets is approximately one-half the tensile strength of the alloy, while the bearing strength of the magnesium-alloy sheet is approximately 50 per cent greater than its tensile strength.

Magnesium alloys are all easily machined. Both speed and depth of cut can be materially increased over the usual shop practice with other metals, while light finishing cuts give a smooth surface that can be held to exact dimensions.

* * *

One-Piece Herringbone Gears for Gear Pumps of High Capacity

Unusually high pressures are now possible with pumps of the gear type. In the past, applications of these pumps have generally been limited to low-pressure requirements, as in the circulating of lubricants for machine tools. Many pump manufacturers have now adopted the Farrel-Sykes herringbone gears, made by the Farrel-Birmingham



Herringbone Gears of the One-piece Type Used in Gear Pumps for Obtaining Pressures up to 1500 Pounds per Square Inch

Co., for obtaining pressures up to 1500 pounds per square inch. These gears are also adapted to large capacity pumps. For example, the gears shown run at 435 revolutions per minute and pump 625 gallons per minute against a head of 200 pounds per square inch.

Simplicity of pump design resulting from the use of these gears permits economical manufacturing and high operating efficiency. The shape of the tooth is designed to reduce trapping of the liquid and to eliminate noise.

* * *

In times of depression, there is usually an effort on the part of modern-minded management to intensify promotion advertising and sales efforts, in order to get its share of the going business. This is a healthy and normal process, and along these lines we at Westinghouse propose to get our share of the current demand while waiting for a general upturn.—*A. W. Robertson*, Chairman of the Board, Westinghouse Electric & Mfg. Co.

Better Machine Shop Photographs

By WILLIAM E. BARR

THE two preceding installments of this series of three articles have dealt with the fundamental principles of shop photography and the selection of lens equipment, focussing, and lighting. The present article will deal with the kind of film that should be used for machinery photographs and the purposes to which shop photographs may be put.

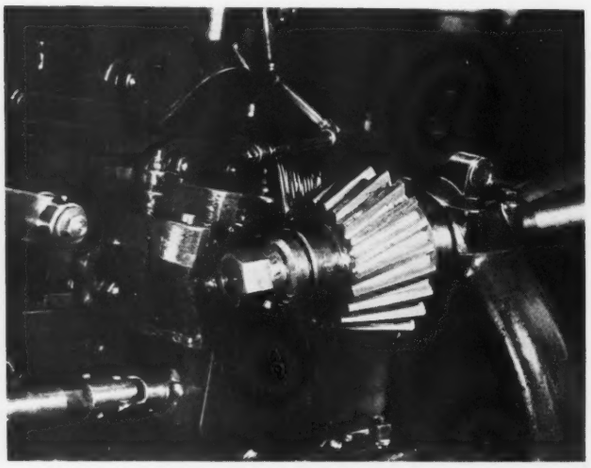


Fig. 1. Photograph Taken on Supersensitive Panchromatic Film of a Machine in Operation Illuminated by Incandescent Lamps

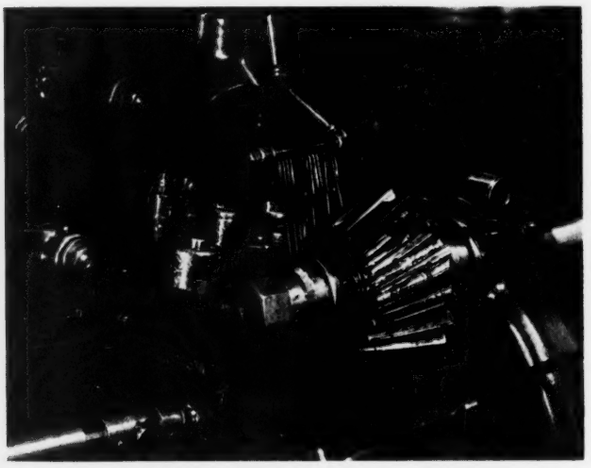


Fig. 2. Photograph of the Same Machine as Shown in Fig. 1, Taken under the Same Conditions, but Using Par-speed Portrait Film

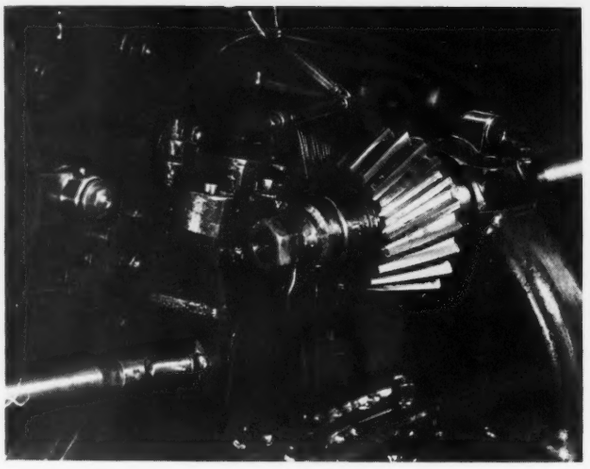


Fig. 3. A Third Photograph of the Machine Taken Under the Same Conditions, but Using Portrait Panchromatic Film

Supersensitive panchromatic film, which is twice as sensitive to daylight as ordinary film and three to five times as sensitive to artificial light, has recently been brought out by the Eastman Kodak Co. This remarkably "fast" film has generally increased photographic quality. Supersensitive panchromatic film is highly valuable for making better machinery pictures, permitting successful shop photographs to be made under conditions previously considered impossible.

As the name implies, the film is extremely sensitive to light of all colors, particularly to incandescent light with which the majority of machinery pictures are made. Its unusual sensitivity to incandescent light is explained by the fact that the film is extremely sensitive to light at the red end of the spectrum, and light from incandescent lamps is full of red rays, undiscerned by the eye.

Supersensitive panchromatic film is indispensable for machine photography in several respects. First, the film is coated with a "soft" emulsion, so that it has the ability to pick up detail in deep-shadowed areas and, at the same time, in areas of bright high lights; photographically speaking, it has a long tonal range. Second, since the film is very "fast," much less light is needed, compared with that required for ordinary types of films. Third, by using the amount of light previously used for slower types of films, smaller lens openings can be employed to increase the sharpness of the picture.

Fourth, the color sensitiveness (ability to render color in correct black and white values) of supersensitive panchromatic film is a highly valuable feature when the machinery being photographed has copper, brass, or bronze parts. Another example

of the usefulness of panchromatic materials in photographing machinery is seen in the case of machinery painted with red oxide of lead, commonly known as "red lead." The red-sensitivity of supersensitive "pan" film records red lead as a medium tone of gray with lots of detail. The "color blind" emulsion film photographs red or shades of red in an almost black tone.

Fifth, supersensitive panchromatic film permits snapshots of machinery with moving parts by the use of a surprisingly small amount of incandescent light. With this new film, exposures of an average subject not more than eight feet from a light source can be made in one thirty-fifth of a second by using only four Kodalites and an f.4.5 lens at its full opening. By increasing the amount of illumination, larger areas can be lighted for pictures of wider scope.

Snapshots of Machinery in Operation

Snapshots of a gear-cutting machine in operation are shown in the accompanying illustrations. Fig. 1 shows the superiority of supersensitive panchromatic film for instantaneous machinery pictures under the conditions specified in the preceding paragraph. Fig. 2 shows a picture made on par-speed portrait film. This picture is decidedly underexposed, indicating a slow emulsion speed, as compared with the supersensitive panchromatic film. Portrait panchromatic film, considered in the ultra-speed class two years ago, was used for the picture shown in Fig. 3, but it falls short of the supersensitive panchromatic photograph reproduced in Fig. 1, as regards detail and brilliance.

Short exposure by incandescent light, which is now possible with supersensitive "pan" film, is decidedly helpful when machinery pictures include operators at work. When ordinary types of films are used, time exposures are nearly always necessary, and this means instructing the man to stand motionless during the exposure from the time a prearranged signal is given. This generally results in stiff unnatural poses on the part of the operator. Instantaneous exposure permits recording the machines and operators actually in the process of doing something.

It is impossible to take advantage of the *maximum* sensitivity of supersensitive panchromatic film when photoflash bulbs are used. Photoflash light is estimated to contain more red rays than daylight but considerably fewer red rays than are contained in incandescent light. In spite of this fact, supersensitive panchromatic film is "faster" than ordinary types of film when exposed to light from photoflash bulbs, thus permitting "stopping down" the lens diaphragm for greater sharpness throughout the picture, commonly known as "depth of field."

Some of the Many Uses for Shop Pictures

There are hundreds of uses for record-type shop photographs. Standard-practice photographs recording the procedure in setting up machinery, etc., are useful as accurate references when work of the same or similar nature is undertaken in the future. They will minimize trial and error methods and save a great deal of time that ordinarily would be required if it were necessary to rely upon blueprint specifications and written or oral instructions.

Construction-record pictures provide a photographic history of the construction of machinery. These are valuable as progress records, and often draw attention to defects that can be corrected immediately. Photographs of standard requirements in the purchasing department save written explanations and frequently speed up shipments.

Photographs are often valuable in patent litigation, because they are accepted as evidence of priority rights. They should be dated and filed with written descriptive matter. Historical or progress photographs have proved the means of establishing patent rights.

Pictures of finished products are of value for historical files, advertising and general publicity, reference in engineering departments, and executives' files.

Photographs of machinery before shipment and of machines damaged in transit constitute conclusive evidence in freight claims. They save much time and explanation, and may lead to speedy adjustments, as well as to safer crating, packing, and shipping practice.

Photographs should be made of serious accidents to prevent their recurrence, to file with claims, and to use as publicity for drawing attention to danger hazards. Photographs of all devices used in safeguarding machines should be recorded, not only for publicity purposes and for the instruction of employes, but also to establish the company's safeguarding methods in view of possible accidents or litigation.

[While there are no publications dealing entirely with the photography of machinery, there are occasional articles in the photographic magazines that might prove helpful to readers who wish to go into more detail in studying the subject of shop photography than can be given in MACHINERY. Among the leading photographic journals are: *Photo Era*, Wolfeboro, N. H.; *Camera*, Philadelphia, Pa.; *Commercial Photographer* and *Abels Photographic Weekly*, Cleveland, Ohio; *Camera Craft*, San Francisco, Calif.; and *Applied Photography*, Rochester, N. Y.]

* * *

Foundrymen Postpone Exhibition

The previously announced thirty-sixth annual exhibition and convention of the American Foundrymen's Association, to be held in the new municipal Convention Hall at Philadelphia, Pa., has been cancelled. Instead, the American Foundrymen's Association will hold its annual convention, without an exhibition, at the Hotel Statler, Detroit, Mich., May 3 to 5. The exhibition will be postponed until the spring of 1933.

Oxy-Acetylene Cutting Applied to Cast Iron

The Cutting of Steel by the Oxy-Acetylene Process is Well Known, but it is Not Generally Realized that Cast Iron is Also Cut Effectively by this Means

By GEORGE L. WALKER
Air Reduction Sales Co., New York City

THE opening of tap holes in blast furnaces was probably the first successful application of oxy-acetylene cutting to cast iron. A length of iron pipe, connected to a source of oxygen supply, is used for this work. The spot where the hole is to be pierced is heated to nearly the fusion point with an oxy-acetylene welding torch. At the same time, the end of the pipe is also heated to the ignition temperature. A stream of oxygen is then allowed to flow through the pipe and impinge against the heated spot of cast iron, which is quickly pierced by the combined action of the burning iron pipe and the oxygen stream. Once started, the reaction is very vigorous.

Development of Oxygen Lance for Cutting Metals

Experience in opening tap holes showed that greatly increased activity was obtained by using pipes having thicker walls or by inserting steel rods in the pipe to furnish additional fuel and heat. Insertion of the rods also reduces the effective opening in the pipe, thereby increasing the velocity of the oxygen stream and its eroding effect.

This process is known as the oxygen lance method; and with certain modifications, is widely used for cutting large sections of cast iron, steel, and other materials. Cross-sections through various types of oxygen lances used for piercing both metallic and non-metallic materials are shown in Fig. 1.

Theory of Cutting with Oxygen Lance and Oxy-acetylene Cutting Torch

The experiment of burning a watch spring in an atmosphere of oxygen, as performed in high school laboratories, illustrates the principle of metal cutting. In this familiar experiment, sulphur or some other similar substance is placed on the end of the watch spring and ignited. In the air, the sulphur simply burns off and the watch spring is not seriously affected. However, when the spring with the burning sulphur on the end is placed in an atmosphere of oxygen, the steel spring immediately takes fire and burns rapidly, throwing off a shower of sparks. This same principle is used in oxy-acetylene cutting.

When an oxygen lance is used, the work is first heated to the ignition point with a welding torch or other means. The oxygen lance is then used to direct the oxygen on the metal at the point to be cut. When an oxy-acetylene cutting torch is used, the spot where the cut is to start is raised to the ignition temperature by the preheating flames of the torch itself. These oxy-acetylene preheating flames surround the oxygen orifice in the cutting torch. When the ignition point has been reached, a valve in the cutting torch is opened by means of a trigger or lever, and a jet of commercially pure oxygen is directed against the hot material, which starts to burn, the same as coal in a furnace or the watch spring used in the chemical experiment described.

Theoretically, combustion, once started, should continue as long as oxygen surrounds the material and without further aid from the preheating flames. In practice, however, it is necessary to continue the preheat as long as the cut is advanced. Some metals are cut or burned with more difficulty than others. Ferrite or pure iron burns or cuts readily; but

Fig. 1. Cross-sections of Different Types of Lances for Piercing Metallic and Non-metallic Materials

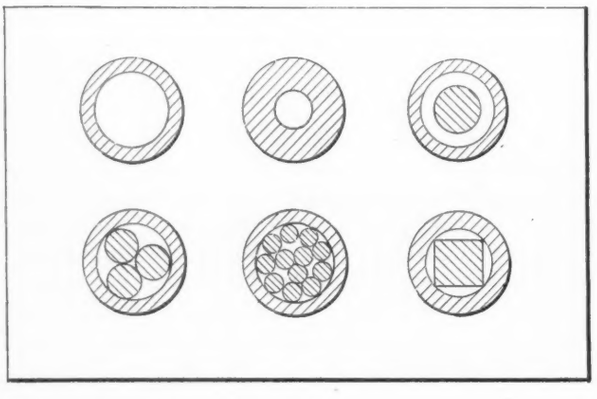
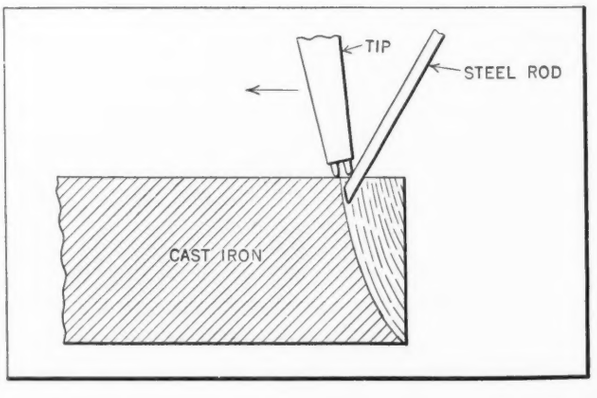


Fig. 2. Diagram Illustrating a Method Often Employed in Piercing Cast Iron and Other Metals



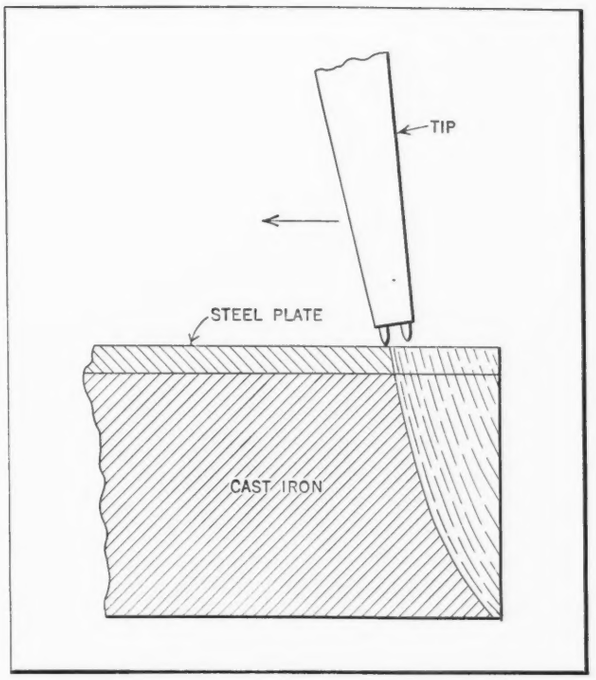


Fig. 3. Another Method of Cutting Cast Iron, in which a Steel Plate is Placed over the Surface of the Iron

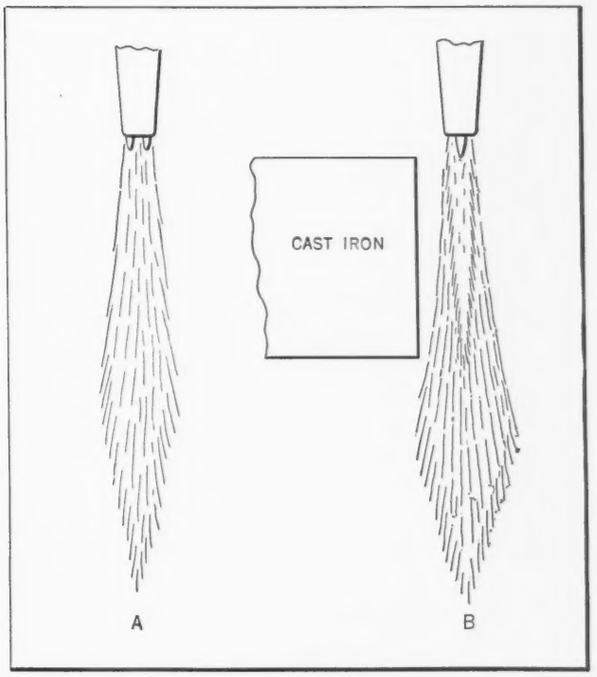


Fig. 4. (A) Neutral Flame; (B) Excess Acetylene Flame Properly Adjusted for Cutting Cast Iron

when the ferrite is mixed with other elements to form the various types of steel and cast iron, the difficulty of cutting it is increased. Iron and straight carbon steels are all readily cut with the oxy-acetylene torch. However, cast iron, although similar to steel in some respects, contains larger amounts of carbon and other impurities and is not cut so easily.

Very Small Percentages of Impurities in Oxygen Increase Consumption

Laboratory tests have shown that, in cutting steel, when the purity of the cutting oxygen is decreased from 99.5 to 99 per cent—a mere matter of one-half of one per cent—the oxygen consumption for a given cut increases over 12 per cent. As this small increase in impurities so greatly affects the cutting efficiency on steel, it is evident that the large volumes of white and yellow flames and other gaseous impurities formed in cutting cast iron seriously impede the operation.

Development of Cutting Equipment

As cast iron was first cut successfully with the oxygen lance, an adaptation of this principle was utilized for experiments in cutting cast iron with the oxy-acetylene torch. This method consists of introducing a steel rod, as fuel, into the stream of oxygen at the surface of the cut, as illustrated in Fig. 2. This method is still used to some extent for piercing cast iron and other metals.

Another method consists of laying a strip of steel or "waster plate" over the surface of the cast iron or other metal to be cut, as shown in Fig. 3. The third method employs a stream of iron powder, injected into the cut along with the cutting oxygen jet. Finally, cutting tips for cast iron and methods of manipulating the torch have been developed which practically supersede the first three methods, except in special cases.

Cutting Tips Used for Cast Iron

Cutting tips for cast iron are identical in construction with the regular line of tips for cutting steel, but they have larger and usually more preheating flames. This serves two purposes: (1) It preheats the cast iron to a higher temperature, thereby increasing its affinity for oxygen; and (2) it permits the use of more acetylene than is required to preheat the surface and start the cut. The excess acetylene is carried down into the cut, where it combines with the oxygen, giving off heat at the point where it is most needed to carry on the reaction.

Adjustment of Preheating Flame

In cutting cast iron, the preheating flames are adjusted so that they will be carburizing, that is, so that they will have an excess of acetylene. This excess of acetylene is very important. An excess acetylene "streamer" extending from 2 to 3 inches beyond the end of the tip is frequently recommended. Recent tests in cutting cast iron from 1/2 inch to 12 1/2 inches in thickness showed that the best results were obtained when the excess acetylene streamer appeared approximately equal in

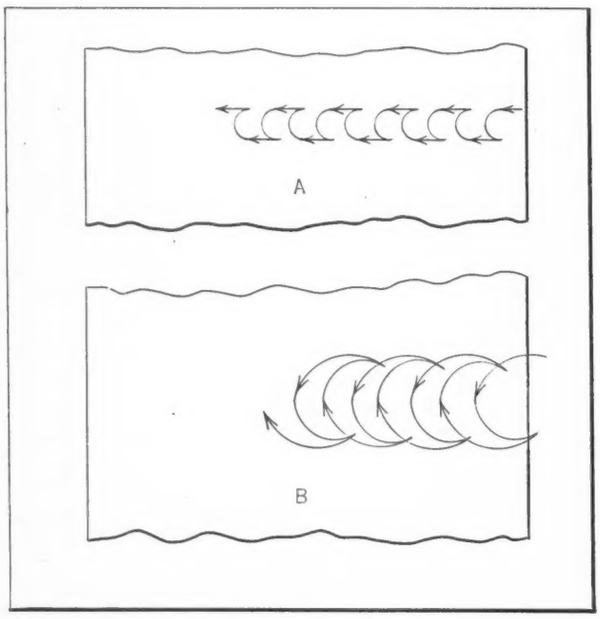


Fig. 5. (A) Movement of Torch and Tip when Cutting Cast Iron of Thin Section; (B) Movement of Torch and Tip when Cutting Heavy Sections

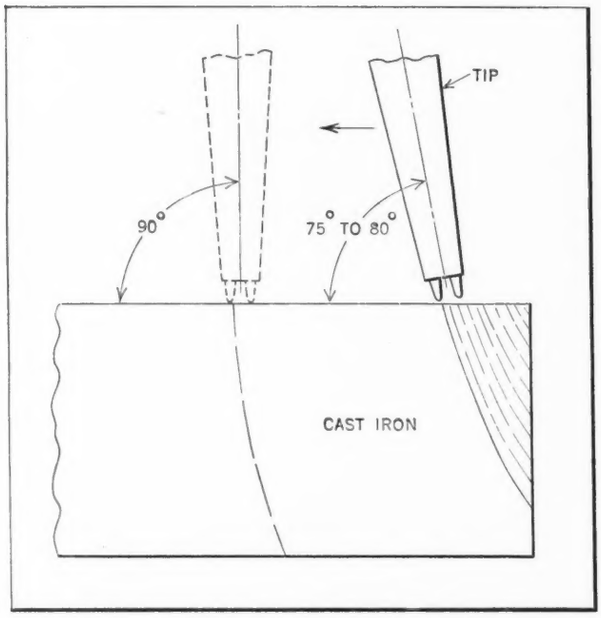


Fig. 6. Angle of Tip at Start and when Cut is Under Way; These Angles are Preferred when Preheating Flames are Adjusted Properly

length to the thickness of the cast iron to be cut, as illustrated in Fig. 4.

To obtain this adjustment, the size of the preheating holes in the tip must be sufficient to allow for the excess acetylene and yet, at the same time, supply enough oxygen to produce a flame temperature that will start the cut promptly. Hence, the preheating flames for cutting cast iron should be much larger than for steel. Skilled operators, familiar with the technique of cutting cast iron, require less time for preheating than beginners.

Oxygen Pressure for Cutting Cast Iron

Excessive oxygen pressures are often used in cutting cast iron, and more difficulties are experienced from this source than from insufficient pressures. Ordinarily, the pressure recommended is somewhat higher than for steel. Even in steel cutting, excessive oxygen pressures are often employed. For example, many operators use a cutting oxygen pressure as high as 150 pounds per square inch, although it is possible to cut the same steel and make a cleaner cut at higher speed with approximately half as much pressure. Similarly, cast iron 12 inches thick can also be cut faster, cleaner, and with less difficulty by the use of approximately 75 pounds per square inch oxygen pressure. The higher pressures that are sometimes recommended are excessive.

Manipulation of the Cutting Torch

The cutting of cast iron is best accomplished by manipulating the torch so that a slight semicircular oscillating motion is imparted to the tip. The tip and cutting oxygen jet are made to describe a small half circle, bisected by the line of cut. A similar half circle is then described, in a reverse direction, at the same time manipulating the tip so as to advance slightly along the line of cut. The advance should be just sufficient to sweep the leading edge of the cast iron in the cut. The radius of the half circles described should be small (3/16 inch or less) to give a kerf of about 3/8 inch on heavier cuts and less on lighter material.

The semicircular oscillating path followed by the tip, advancing slightly along the line of cut at each oscillation, is illustrated diagrammatically in Fig. 5. For comparatively heavy material, the movement shown in the lower view is most successful. In cutting cast iron less than 1 inch thick, a modification of this movement as shown in the upper view gives the best results. The same semicircular oscillating motion is used, but the tip is advanced slightly in a straight line, parallel to the cut, at the side of the kerf between the semicircular movements.

Method of Starting the Cut

The preheating flames are played along the line of the cut from top to bottom until the cast iron is well heated, before the cut is started. The hotter the cast iron is, the easier it will be to cut. In starting the cut, the torch is held with the cutting tip inclined in the direction of the cut at an angle of 75 to 80 degrees with the surface of the material, as shown in Fig. 6. This angle may be maintained until the cut is completed, if desired. However, the best practice is to gradually bring the angle of the cutting tip up to 90 degrees with the surface of the work as the cut progresses. This must be done carefully to avoid losing the cut.

Under-cutting the cast iron in the manner indicated in Fig. 7 will greatly facilitate starting the cut at the top. This procedure heats the lower part of the casting and permits the cut to penetrate rapidly and continue without interruption. However, if the cast iron has been well heated by playing the preheating flames along the line of the cut from top to bottom, under-cutting is usually unnecessary.

Continuing the Cut

When the cut is once under way, the operator continues the semicircular oscillating motion of the tip regularly and uniformly. There should be no stopping until the cut is finished. Each semicircular movement of the tip should just sweep the leading edge of the cut with the oxygen jet. No attempt should be made to advance the jet too far at a time or to allow it to bite too deeply into the metal, as this will cause the cut to stop or a black spot to appear under the jet, as illustrated at *B*, Fig. 8. When this develops, the tip should be moved to one side of the dark spot and the spiral motion continued as before. The kerf is somewhat wider in a cast-iron cut than in a steel cut. However, it need not be excessively wide, provided the cast iron is clean and the operator proficient.

Field of Application of the Process

In the case of steel, the oxy-acetylene cutting torch has proved itself an economical tool for an almost unlimited number of applications in fabricating, manufacturing, and demolishing work. The oxy-acetylene cutting of cast iron, however, appears to be limited at the present time to making alterations in and repairs to machinery and demolishing castings.

Alterations in machines often require that only a part of the casting be cut away. When this is the case, the cutting torch is very useful and saves both time and expense.

Repairs of cracks or breaks in large cast-iron members by welding require preparation of the section by "veeing." For doing this work, the oxy-acetylene cutting torch has proved itself of great value. This is probably the most extensive application of cast-iron cutting at present.

For demolishing castings, other methods are often more economical, such as the use of skull-cracker weights, dynamite, or other explosives. However, these facilities are not always available, nor can they be safely applied in every case, because of the location of the casting. In such instances, the oxy-acetylene cutting torch provides the only method of doing the work, unless sawing or drilling operations are employed, and these are slow and expensive, especially when the casting must be cut in place.

While, therefore, the field of oxy-acetylene cutting of cast iron has not been particularly broad, the process has in many instances proved of great economic value. When the field of usefulness becomes more generally appreciated, the process will be used to advantage much more widely than at present.

The cost of making a cut in cast iron is considerably higher than the cost of making a similar cut in steel. The quality of the cast iron and the proficiency of the operator are both factors that appreciably affect the cutting cost. If the method of procedure described in the present article is closely followed, an operator without any previous experience will soon learn to make cuts in cast iron cheaply and skilfully.

Fig. 7. If the End of the Cast Iron is Well Heated by Playing Preheating Flames along Line of Cut from Top to Bottom, Undercutting Will Not Be Necessary

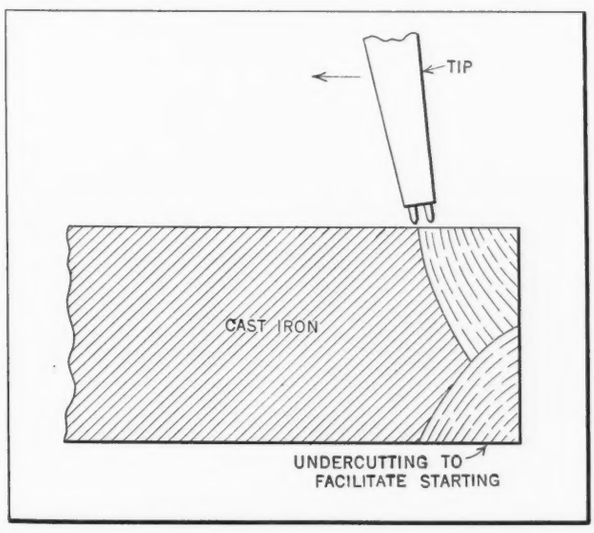
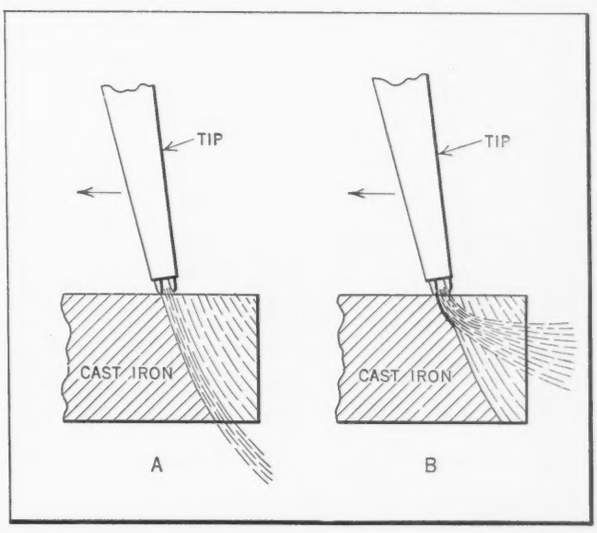
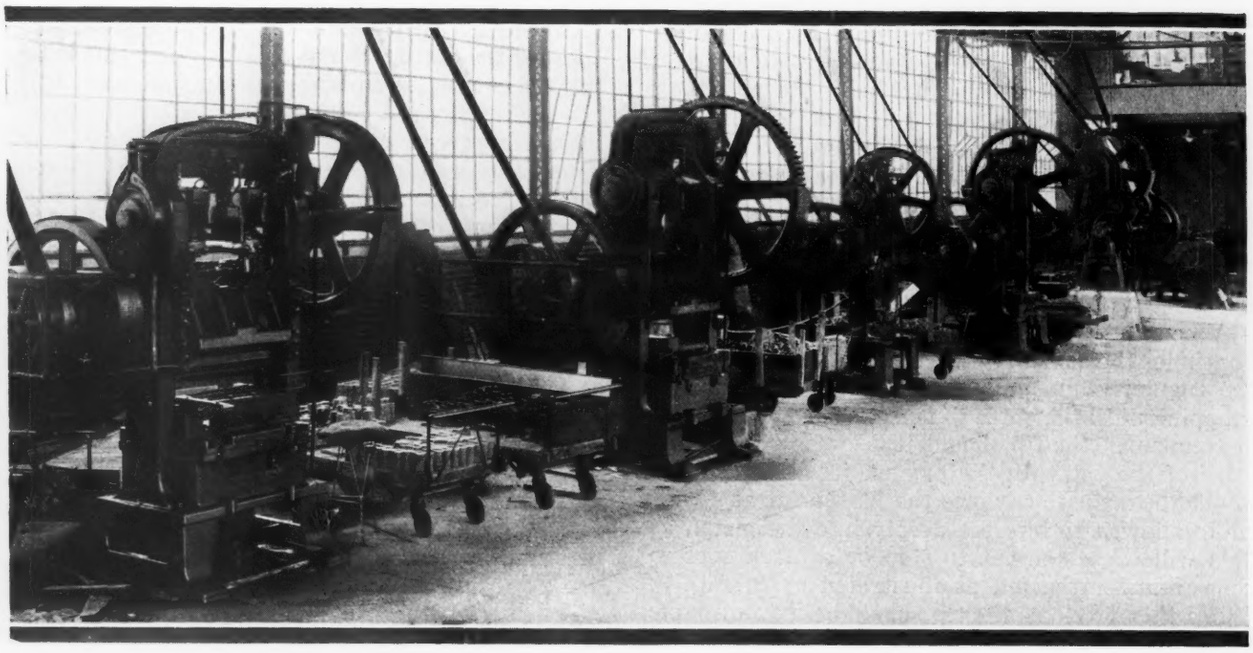


Fig. 8. Cutting Oxygen Jet Should Just Sweep Edge of Cut, as Shown at A, and Not Advance Too Deeply, as Shown at B; Otherwise the Cut Will Stop





Making Four Hundred Welded Steel Pulleys a Day

Resistance Welding is Used for All Assembling Operations from the Time the Flat Stock Goes to the Presses Till the Pulley is Completed

By M. L. ECKMAN, Research Engineer
Federal Machine & Welder Co., Warren, Ohio

SPECIAL equipment developed by a manufacturer for his own product often arouses a general demand, and as a result, the manufacturer becomes engaged in the production of an article that is entirely different from his regular line. The steel pulleys illustrated in Fig. 1 are examples of a product that originated in this manner. These pulleys have been giving good service for the last fifteen years under all conditions and climates—from the rubber plantations near the equator to the mines in Alaska and Siberia.

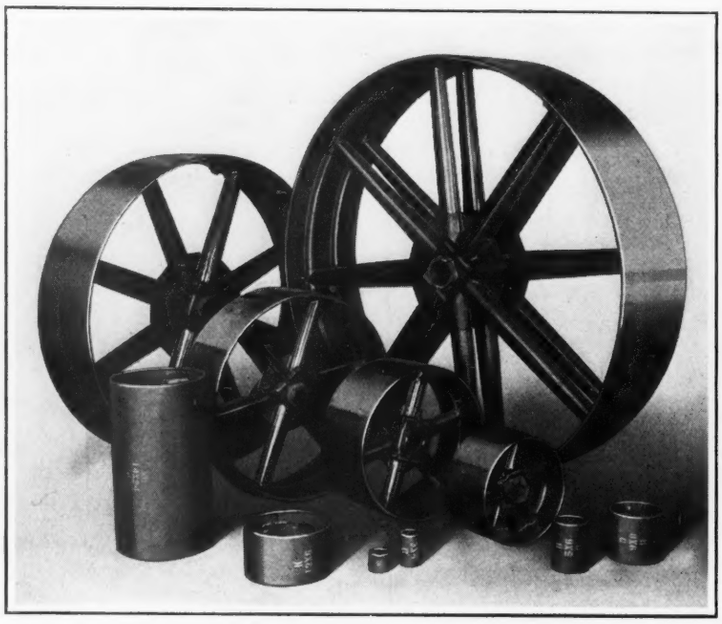


Fig. 1. Welded Steel Pulleys Ranging from 3 to 72 Inches in Diameter

For twenty-five years, the Barry Mfg. Co. has been making equipment for the pearl button industry. This line includes tumbling barrels for polishing pearl buttons. At first, considerable difficulty was experienced in obtaining driving pulleys for the tumbling barrels that would stand up under the shock and strain of repeated reversal. To overcome this trouble, Nicholas Barry, who had an important part in developing the pearl button machinery, set about to design a pulley that would be satisfactory for this service. As a result, the Barry steel pulley was brought out in 1915 by the Barry Mfg. Co., Muscatine, Iowa. This com-

pany is now a subsidiary of the R. & J. Dick Co., Inc., Passaic, N. J., through whose selling organization the pulleys have been widely distributed.

The pulleys are designed to combine light weight and strength. This combination of desirable qualities has been facilitated by employing electrical resistance welding for assembling the formed steel parts that comprise the pulleys. Many improvements have been made in the welded wheels since

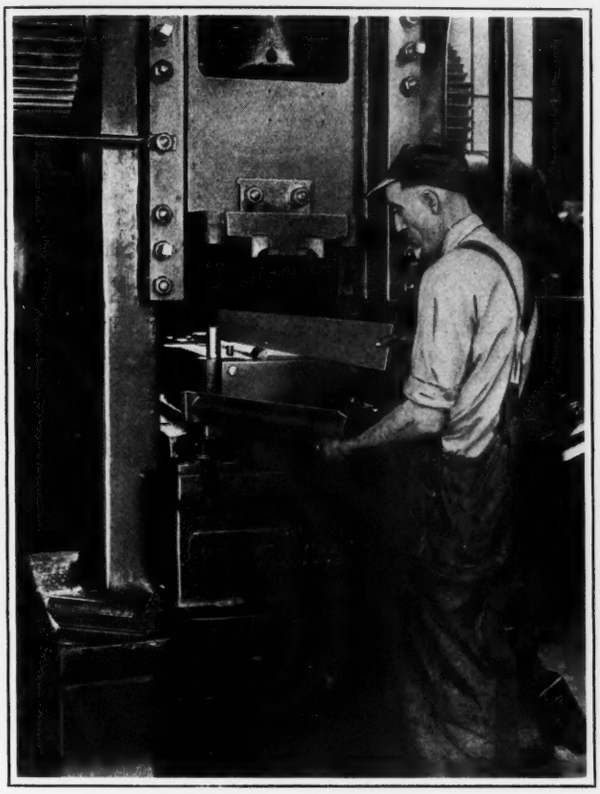


Fig. 2. Forming Half-sections of Pulley Spokes from Flat Steel Blanks

they were first placed on the market in 1915, but the three original outstanding features remain the same, namely, (1) a hexagonal hub, (2) tubular construction, and (3) assembly by Federal resistance-welding equipment.

The specially designed automatic spot-welders used are made by the Federal Machine & Welder Co., Warren, Ohio. Assembling the parts by welding has been found to give a sturdy reliable product at low cost, and one that does not loosen or come apart through continued use. About three hundred different pulleys are manufactured. These cover a range of diameters from 3 to 72 inches, in either straight- or crown-faced types, and in widths from 2 inches up. Referring to Fig. 1, it will be noted that the smaller pulleys have six arms, whereas the larger sizes have eight arms, and the double-arm types have sixteen arms.

The production line of heavy-duty presses used in punching out the blanks and forming some of the parts that go into the construction of the all-welded pulley is shown in the heading illustration. The plant is planned and laid out for progressive production methods, the stock moving from one operating position to the next with a minimum amount of handling.

Forming Sheet-Steel Parts for Pulleys

The steel is bought in rolls or standard sheets, according to requirements. Careful planning and laying out keeps the waste material down to a minimum. A press equipped for forming a half-spoke is shown in Fig. 2. The operator is shown holding

Fig. 3. Drawing and Forming Pulley Hubs in a Powerful Hydraulic Press

a blank and a finished half-spoke. On the base of the press are some half-spokes for a smaller pulley which were formed by the same die as was used for the longer spoke. The powerful hydraulic press used to draw and form the hexagonal pieces that form the hub of the pulley is shown in Fig. 3.

Assembling and Welding Various Pulley Members on Counterbalanced Fixtures

Fig. 4 shows the hubs, half-spokes, and quarter-spokes assembled on an aluminum fixture for

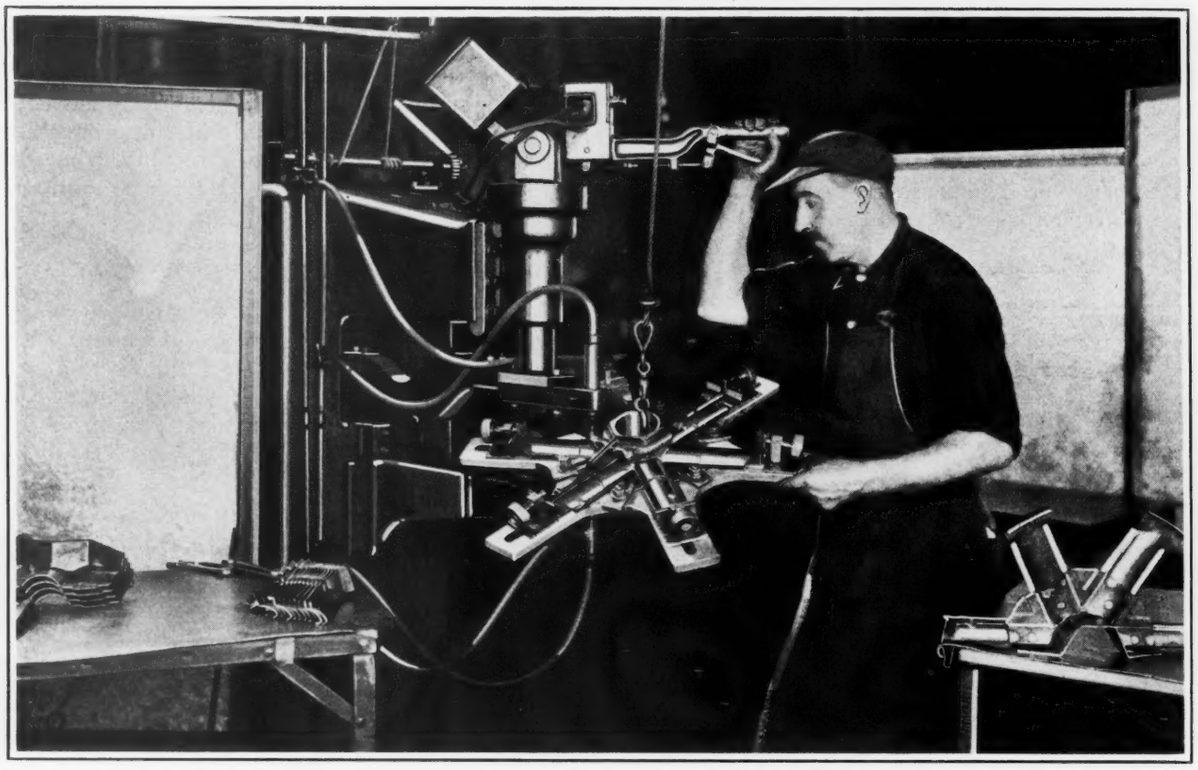


Fig. 4. Hubs, Half-spokes, and Quarter-spokes Assembled on a Counterbalanced Fixture Ready for Resistance Welding

welding the spokes to the hubs. This aluminum fixture is counterbalanced overhead in such a manner as to facilitate easy handling while loading, unloading, or welding. Two assemblies like the one shown on the bench at the right are welded at one time, forty welds being required for each pulley.

Four quarter-spiders or two half-pulleys are assembled on a solid locating bushing in a counterbalanced fixture such as shown in Fig. 6, and spot-welded along the hubs and edges of the spokes. For this assembling, forty-two welds are required per pulley.

The equipment for concentrically locating and welding the U-shaped fillets to the spokes is shown in Fig. 5. The parts on the table give a good idea of how the assembly is made. For this operation, twenty "series" welds are made, making a total of forty single welds. An unusual feature of this operation is the "series" weld made by means of the copper spacing block seen in the fillet between the welder points. With this arrangement, a weld is made through one of the quarter-spokes and fillet, after which the current travels through the copper block and welds the opposite side of the fillet to the opposite quarter-spoke of the pulley.

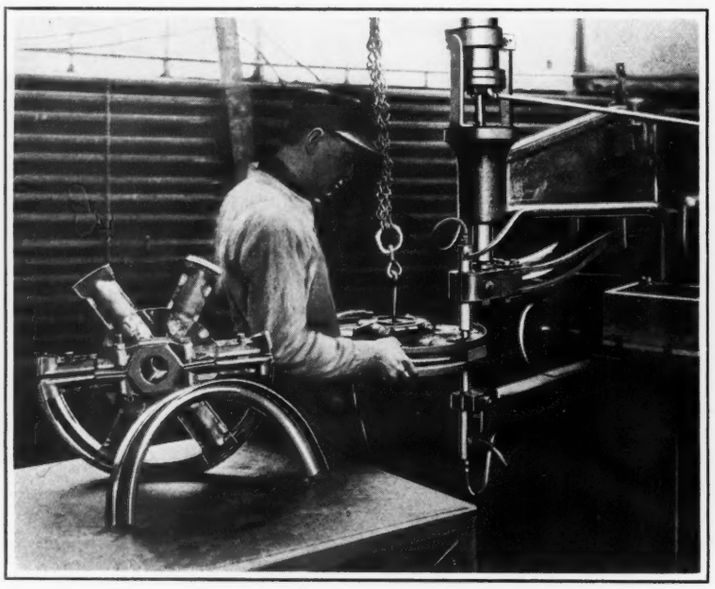


Fig. 5. Welding the Rim Fillet to the Spokes

The double-type automatic spot-welder that indexes and automatically welds the fillet to the rim on both sides simultaneously is seen in Fig. 8. This machine is adjustable for different sized fillets. The final operation before inspection is the curling of the rims in the powerful hydraulic press shown in Fig. 7.

A pulley having a diameter of 36 inches and a face

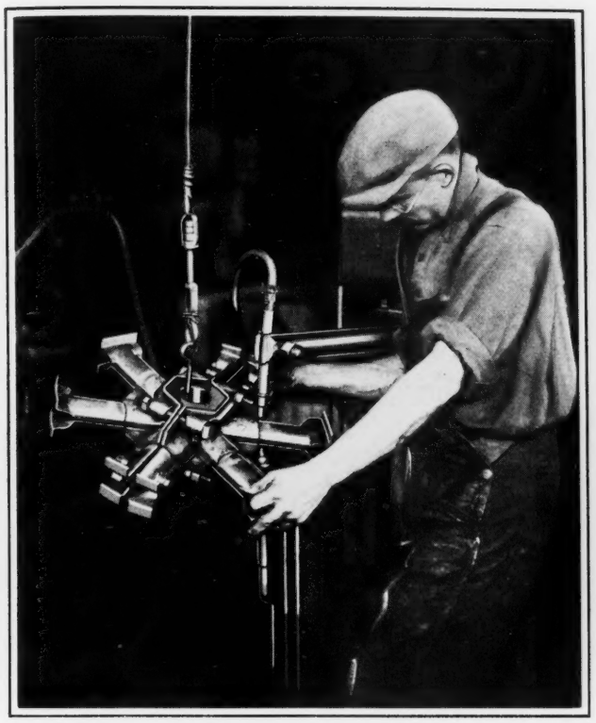


Fig. 6. Two Half-sections of a Pulley are Assembled on a Solid Bushing and Welded Along the Hubs and Edges of Spokes

Fig. 7. The Final Operation on the Pulleys is Rolling or Curling the Edges of the Rims in a Large Hydraulic Press

width of 6 inches is composed of thirty-six formed steel parts which are electrically welded together to form a complete unit. The actual time required for locating and welding a pulley of this size does not exceed fifteen minutes.

Inspection is rigidly carried out and includes mounting each pulley individually on a master shaft and inspecting it for alignment, concentricity, balance, and strength. After the pulleys have passed inspection, they are painted and passed through the drying oven. From this operation, they are taken to the stock-room, where they are systematically arranged to facilitate immediate shipment in orders of any size, ranging from one pulley to a carload lot. The hub bushings are stocked separately, according to size, and are interchangeable in any pulley in their respective classes.

The hexagonal bushing, which is seated in the pulley hub, has lengthwise slots in the shaft hole. This construction provides for gripping the shaft uniformly around its entire surface. This type of hexagonal compressible bushing eliminates the necessity for keyseating, although keyseated bushings are also made. Another type of bushing has the key welded in place, so that the hub and key form an integral unit, thus eliminating set-screws.

The welding operations described in the present article are an example of the rapid development that has taken place in the application of the welding process to manufacturing procedure in many fields where it has not been made use of until quite recently.

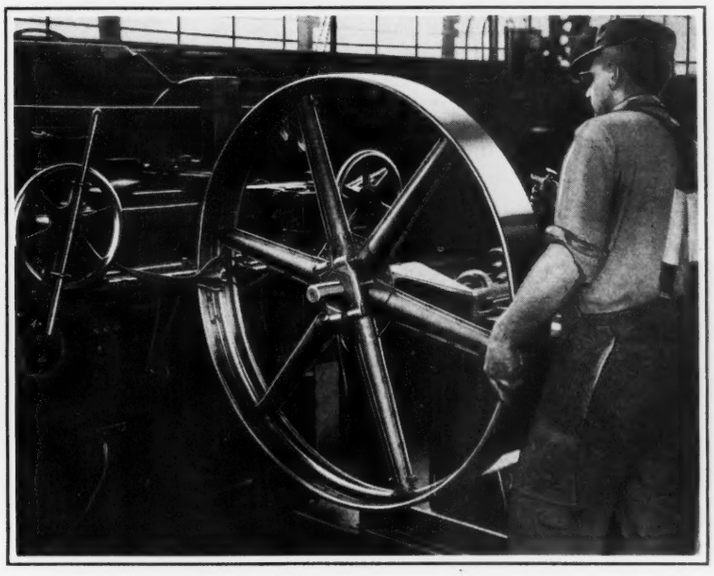


Fig. 8. Spot-welding the Pulley Rim to the Spider

EDITORIAL COMMENT

It takes four years to train a young man to become a toolmaker. During that period he is given careful instruction and taught to do his work according to accepted practice. But a man is appointed foreman without any previous training for the job, it being assumed that he will know by intuition—or, at best, that he will have learned through observation—how to handle the job. Is it reasonable to assume that the foreman's work is so much simpler than the toolmaker's that he should need no previous training?

Industry is beginning to have a new conception of this subject; foremen and supervisors are actually being trained for their jobs. Some plants have achieved remarkable results in this way. They have planned the training program carefully and have recognized its great importance. Most shops, however, are still pursuing the old policy of taking a good man from the ranks and appointing him foreman, hoping that his good sense and native ability will gradually help him to find out for himself that which ought to have been taught him in a systematic way.

Foremen as well as Toolmakers should be Trained for the Job

The question is worth pondering: If it takes four years to make a toolmaker, how long does it take to make a foreman?

Methods of taxation are of the greatest importance to industry. The amount paid in taxes, within reasonable limits, is actually of less importance than the methods and the fiscal policies governing the levy of the taxes. Wise fiscal policies will encourage and stimulate business; unwise taxation programs will hamper and crush industrial endeavor.

Many of the fiscal measures proposed during the past months have been vigorously opposed by some branches of industry, and rightly so. But government cannot be conducted without income, and in opposing unfair and harmful taxes, industry should do something more than take a negative attitude. Would it not be more effective if business and industrial enterprises cooperated through their trade associations, or otherwise, in formulating a rational method of taxation that could be proposed as a counterplan to the methods being opposed?

This applies to governmental measures of all kinds. It is not enough merely to criticize and oppose; real results are obtained only through constructive effort. Take the case of unemployment, for example. Practically everybody agrees that something should be done to prevent the recurrence of the deplorable conditions existing at the present time. Some of the methods for unemployment relief discussed in Congress have proved impracticable abroad; they would place an enormous burden of taxation on the country without providing an adequate remedy for the evils of unemployment.

Industry Must Help to Guide Important Public Policies

The only effective way to combat the propaganda for unwise unemployment relief is for business and industry to formulate a definite plan that will prevent the recurrence of present conditions. No plan can be perfect, but certainly some plan can be devised whereby widespread unemployment can either be prevented or its effects greatly minimized. Only by such concerted constructive action can industry expect to gain a hearing in legislative matters.

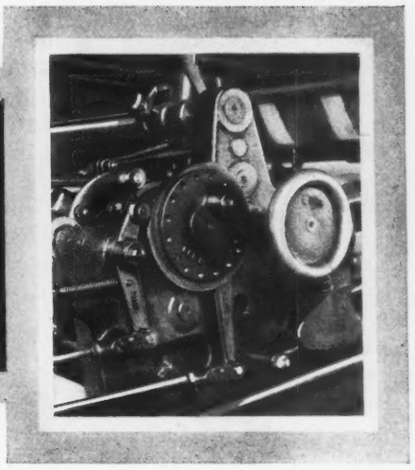
A great opportunity presents itself to industrial and trade organizations at the present moment to assume constructive leadership in the formulation of governmental policies that vitally affect the welfare, not only of industry, but of the nation as a whole.

The remarkable advance in automobile design and the rapidity with which new developments in the automobile industry become everyday practice is due largely to the patent policy that this industry has followed for many years. Practically speaking, patents are common property in the industry. This is the reason that no patent suits are heard of at the present time in that field.

The Advanced Patent Policy of a Leading Industry

It is a wise industry that refuses to spend money, time, and effort in patent litigation. At least one machine tool manufacturer has given serious thought to a similar plan for the machine tool industry. Such a plan, he believes, would prove of advantage to the industry and promote the interests of each individual manufacturer, as well as of the industry as a whole. At any rate, machine tool builders, as well as machinery manufacturers in general, will be interested in the automobile industry's experience, as recorded on page 589.

Ingenious Mechanical Movements



Intermittent One-Revolution Drive

By H. E. KITCHEN

The mechanism to be described is designed to revolve a disk intermittently, so that it will make one revolution at the conclusion of the feeding movement of a certain machine. The ratchet wheel *A*, Fig. 1, which is keyed to shaft *B*, revolves continuously at a constant speed. Shaft *B* rotates freely within the boss of disk *C*, but when pawl *D*, attached to disk *C*, is allowed to engage ratchet *A*, the parts *A* and *C* revolve as one unit. Gear *E*, which is keyed to shaft *B*, then transmits motion to a slide (not shown).

At the completion of the feeding movement, shaft *F* is rocked in a clockwise direction until latch *G*, keyed to shaft *F*, moves clear of the drop-bar *H*. This allows bar *H* to drop and clear the end of pawl *D*, which then pivots on stud *J*, under the action of the tension spring *K*, and engages the revolving ratchet wheel in the manner illustrated in Fig. 2.

In order to limit the rotation of disk *C* to one revolution, the projecting lug *L*, affixed to and rotating with disk *C*, engages the upper hook *h* on bar *H*, as shown in Fig. 3. The lug *L* then lifts bar *H* high enough to allow latch *G*, Fig. 1, to re-enter the notch in bar *H*, and hold the latter member in the upper position. This repositioning of bar *H* takes place before one revolution is completed. The continued movement of disk *C* causes the end of pawl *D* to come in contact with the lower projection on bar *H*, thus forcing the pawl out of engagement with the revolving ratchet *A* and arresting the movement of disk *C* after it has completed one revolution. When bar *H* is down, the upper hook *h* must clear the end of pawl *D*, and the lower hook on bar *H* must clear projection *L*, in order to have the mechanism function correctly.

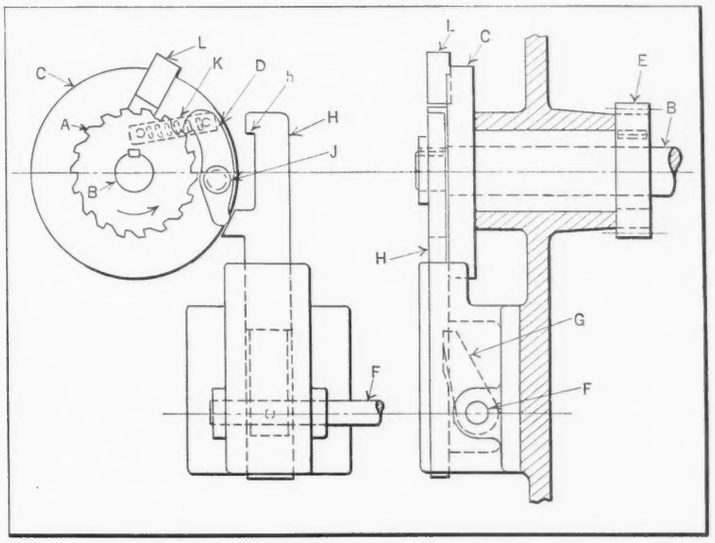


Fig. 1. Mechanism by which Rotating Shaft B Imparts One Revolution to Gear E when Shaft F Releases Latch G

With proper attention to lubrication, bar *H* will function satisfactorily, but dirt or gummy oil will cause it to become stuck in the upper position, as only the weight of the bar itself is relied upon to cause the return movement. It was therefore decided to change this detail. Although a spring could have been used to exert a downward pull on bar *H*, a lever *M*, as shown in Fig. 4, was substituted for bar *H*. This construction was less expensive than the first one, and the rotating movement about fulcrum stud *N* produced less frictional resistance than the sliding movement of bar *H*.

The only other difficulty experienced in the design illustrated in Fig. 1 was with the time interval required to free latch *G* after the drop-bar had been allowed to fall. The rate of the rotation of ratchet wheel *A* is comparatively high, and with a very slow feed, the trip motion shaft *F* did not operate quickly enough. Thus, latch *G* would not be ready to retain bar *H* when the latter member was lifted by the

lug *L*. This meant that the disk would be given a second revolution before pawl *D* was disengaged. To avoid this difficulty, latch *G* was replaced by two latches, as shown at G_1 and G_2, Fig. 4. Latch G_1 is keyed to shaft *F*, but latch G_2 is free to revolve.

When shaft *F* is rocked clockwise, latch G_1 pushes latch G_2 from under lever *M* by means of the pin *P*. Lever *M* then occupies the position shown by the view in the upper right-hand corner of Fig. 4. Thus lever *M* is raised slightly, but when it is released by latch G_2, latch G_1 occupies a position directly under lever *M*, thus preventing it from dropping the full distance. When shaft *F* is released and latch G_1 returned to the original position, the pressure of spring *Q* tends to return latch G_2, but cannot do so because the latch strikes the side of lever *M*. Lever *M* is then free to drop between the two latches and start the one-revolution drive. This arrangement prevents the one-revolution drive from functioning until shaft *F* has been tripped and returned to its original position.

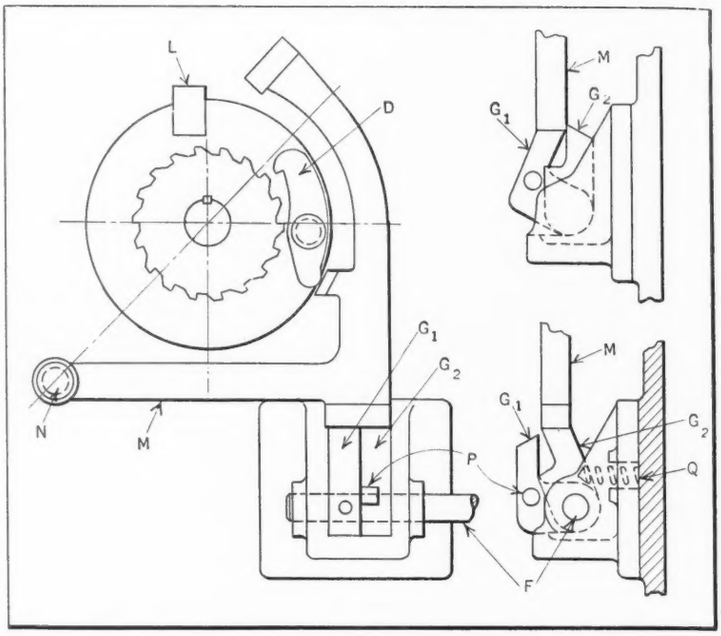


Fig. 4. Improved Development of Drive Shown in Fig. 1

While requiring quite a lengthy explanation, the mechanism described is of simple design; and with slight modifications may be found applicable to various requirements of a similar character.

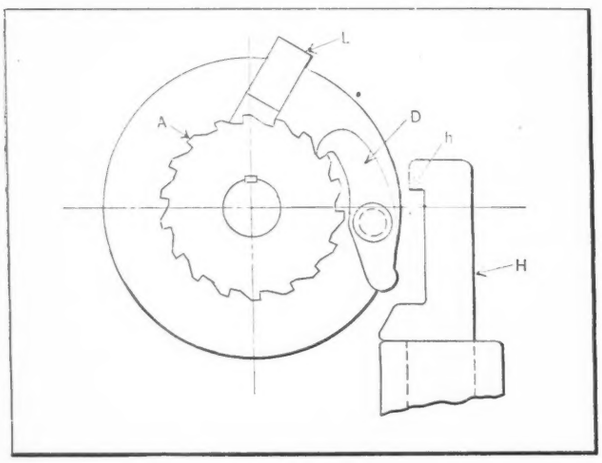


Fig. 2. Position of Bar H after being Released by Latch G, Fig. 1

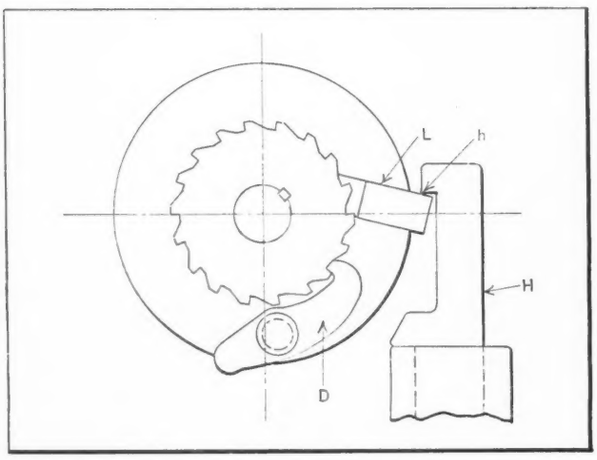


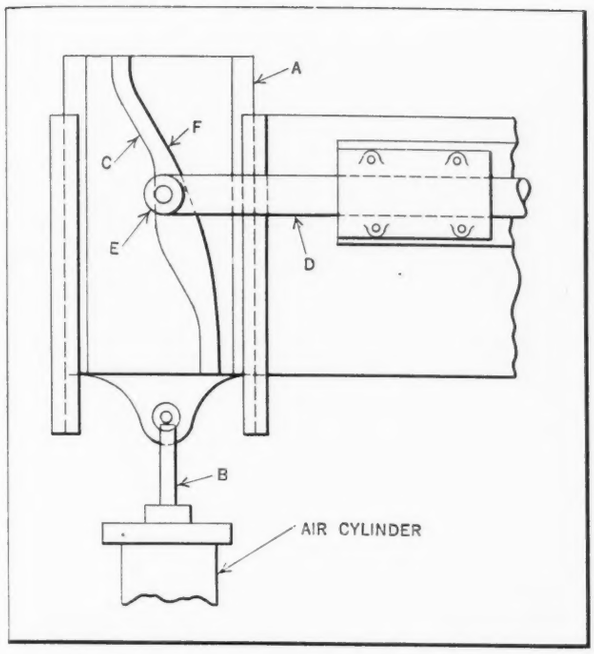
Fig. 3. Lug L Engaging Hook h by which it Lifts Bar H

Mechanism for Obtaining Intermittent Movements from a Constant Reciprocating Movement

By RAYMOND O. KRENGEL

A feeding mechanism operated by an air cylinder was required to convert the constant reciprocating movement of the air piston into an intermittent movement on the outward stroke. This movement was to be at right angles to that of the piston. On the return stroke, the motion was to be continuous and at a constant speed. The mechanism for obtaining these movements is shown diagrammatically in the accompanying illustration. The reciprocating piston *B* is attached to the slide *A*. Slide *A* has a cam groove with the side *C* formed with a dwell to impart the required intermittent movement to the feeding plunger *D* on the outward movement of the piston.

On the return movement, the side *F* of the cam groove returns the plunger *D* to the starting position without the intermittent motion required on the outward movement. There is sufficient friction in the mechanism to keep the roller *E* of the plunger *D* in contact with the sides *C* and *F* on the outward and inward movements, respectively. Automatically operated air valves control the dwell at the end of each stroke. The speed of the feeding and return



Mechanism for Converting a Constant Reciprocating Movement into an Intermittent Movement

movements of plunger *D* is governed by the rate at which air is admitted to the cylinders by the air valves.

Locking Device for Clutch Lever

By J. E. FENNO

Safe operation of an extractor used for drying wiping cloths requires that the cover of the machine be tightly closed before the starting clutch is engaged. One device which complies with this requirement is shown in the illustration. The stationary casing *A* and the cover *B* enclose the rotating container (not shown) for the cloths. The cover is hinged at the left-hand side of the casing and can be secured in its closed position by the clamping lever *C*, pivoted on the stationary bracket *D*.

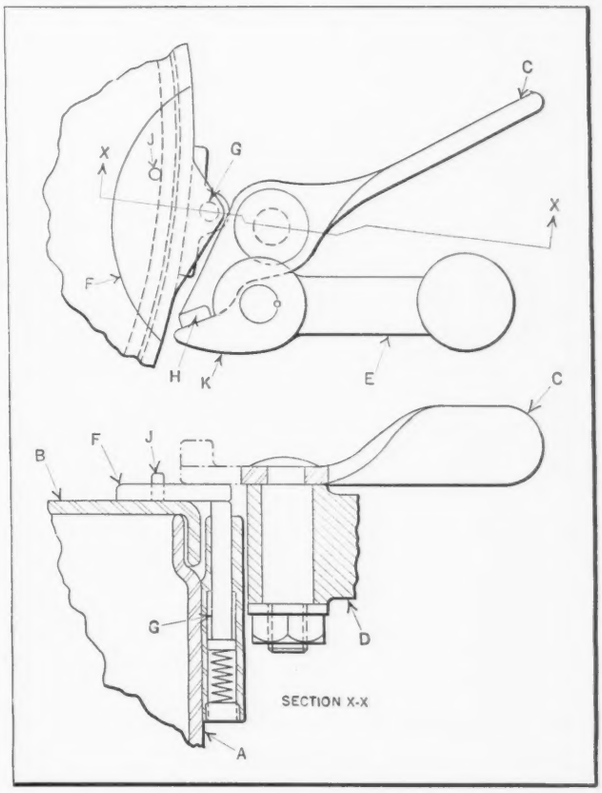
In the position shown, the cover can be swung upward on its hinge to allow loading or unloading of the container. While the cover is up, clutch lever *E* is prevented from being returned accidentally to its engaged position by the projection *H* on the lever *C*. Lever *C*, in turn, is prevented from returning to its clamping position by the spring-actuated plunger *G*, mounted on the casing. With this arrangement, both levers are automatically locked when the cover is up and are automatically released when the cover is in its closed position. As the cover descends, plate *F*, which is welded to the cover, depresses plunger *G* and allows lever *C* to be swung into its clamped position. At this time, finger *K* will clear the projection *H*, permitting lever *E* to be swung in position to engage the clutch. Plate *F* is provided with a stop-pin *J* to limit the clamping movement of lever *C*.

Chicago Machine Tool Dealer Stages Exhibit

During the first week in March, Neff Kohlbusch & Bissell, machine tool dealers located at 2400 W. Madison St., Chicago, Ill., held an exhibition of machine tools in the shop of the Service Tool, Die & Mfg. Co. in Chicago. The exhibition was attended by approximately 1000 equipment engineers and shop executives; this fact indicates that in spite of the business conditions, there is a wide interest in new shop equipment. The machines shown were all of the latest design, and were all under power and in operation.

The machines exhibited included a Greenlee four-spindle automatic screw machine; a Cincinnati plate shear; a Mattison surface grinding machine; a sensitive tool-room drill built by the Providence Engineering Works; a Pels combination shear; a Multi-slide machine built by the U. S. Tool Co.; a Schraner lapping machine; a Swiss jig boring machine; a dynamic balancing machine built by the Globe Tool & Engineering Co.; a Reed-Prentice vertical milling machine; and a Neff Kohlbusch & Bissell high-speed milling machine.

It will be noted that the machines exhibited offered a representative cross-section of new machine tools, either entirely original in design or provided with recent important improvements. All the machines have recently been described in the Shop Equipment News Section of MACHINERY.



Locking Device for Extractor, which Prevents Accidental Shifting of the Clutch Lever

Principles of Hydraulic Systems

A Review of the Principal Means Used for Obtaining Mechanical Movements by the Application of Hydraulic Pressure—First of Two Articles

By CARL MOREY, Consulting Engineer
Big Rapids, Mich.

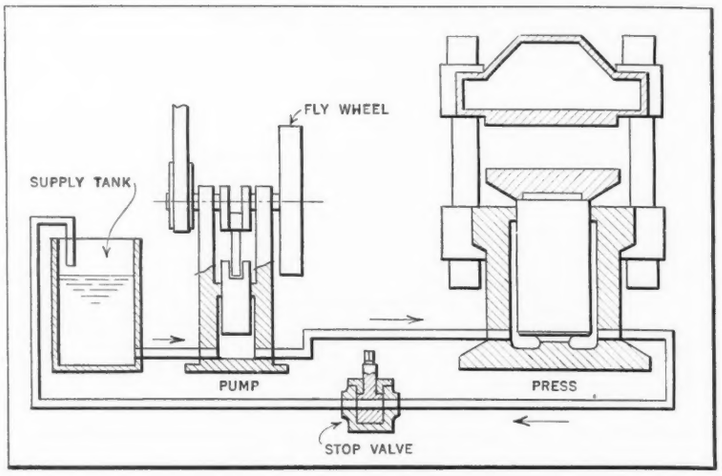


Fig. 1. Early Method of Operating Hydraulic Press, Known as the Impact System

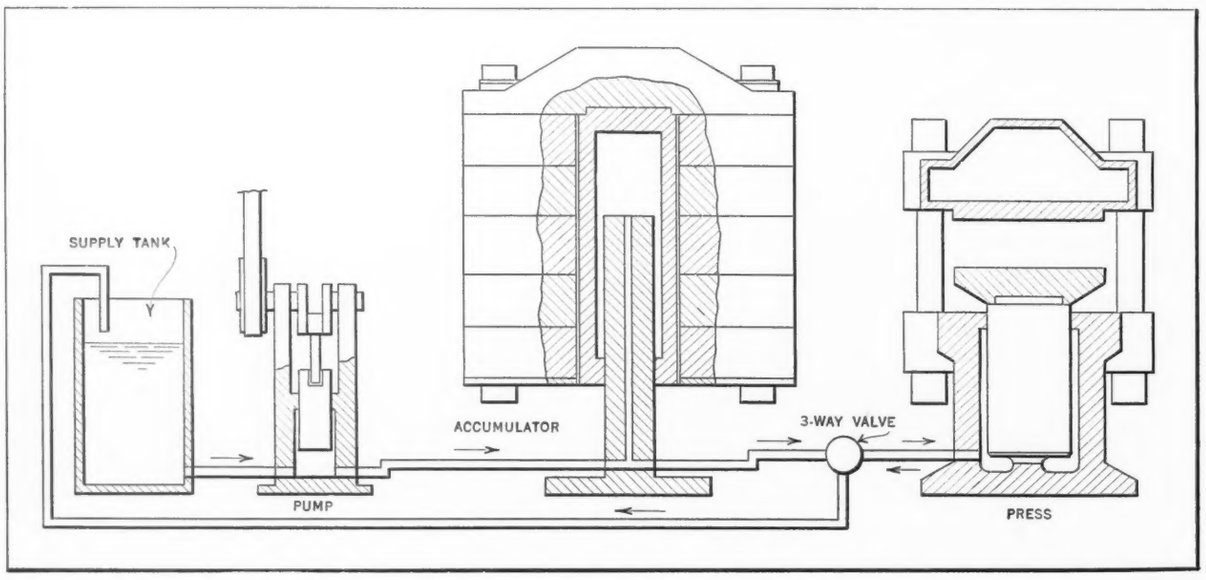
THE term "hydraulics," as applied to machine tools and automatic machinery in general, is construed to mean the transmission of power by means of a fluid, usually oil. The first modern application of the hydraulic principle to machine design was in presses. At the present time, however, slight modifications of the fundamental principle have made it possible to so control hydraulic pressure as to make it one of the most versatile means of power transmission.

The application of hydraulics to machinery was principally a matter of reducing manufacturing costs. Hydraulic systems are inherently flexible, yet there is nothing that is accomplished by hydraulics that cannot be done satisfactorily by mechanical means, if cost is not considered. For constant speed, mechanical devices are usually lower in first cost; but where wide variations of speed are desired, hydraulic means generally effect a marked reduction in first cost, as well as in power consumption, maintenance, and simplicity of operation.

Ordinarily, there are fewer machine parts in a hydraulic system than in a mechanical system accomplishing the same results. With fewer moving parts, there are fewer friction surfaces. Methods of varying speeds are simpler, and the system as a whole is inherently self-lubricating.

There are, however, many applications of hydraulics that are not justified, as the ultimate cost of producing the desired results by hydraulic means in those particular cases is higher than by mechanical means. On the other hand, there are an infinite

Fig. 2. The Accumulator Principle Applied to the Operation of a Hydraulic Press



Applied to Machine Design

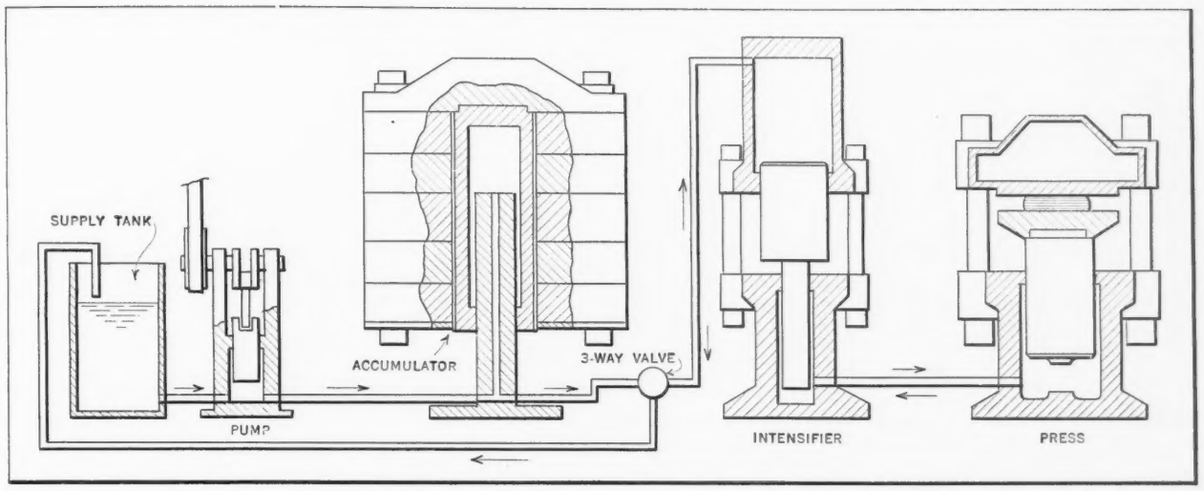


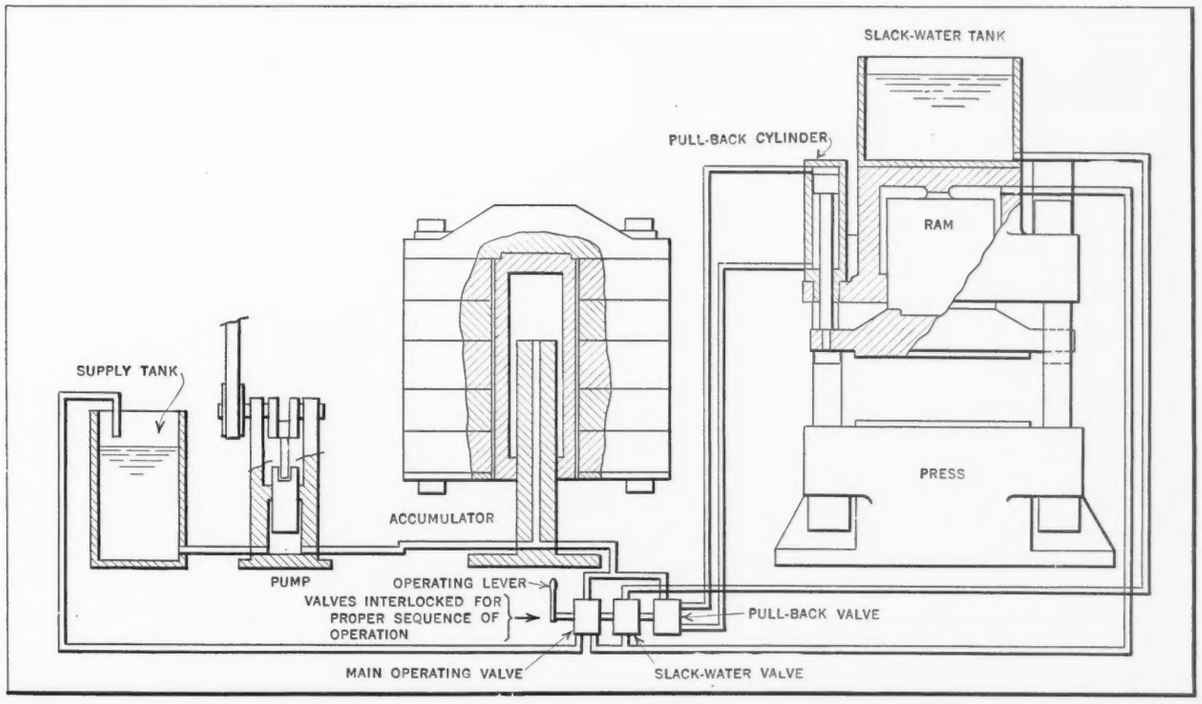
Fig. 3. The Accumulator System, Modified by the Addition of an Intensifier

number of applications ideally suited to hydraulics that are now handled mechanically.

During the last ten years, hydraulics have made phenomenal progress, both in the variety of applications and in the results obtained in specific cases. Two primary reasons lie behind this progress: First, engineers recognized the flexibility of hydraulics; and second, there arose what might be termed a hydraulic "complex" or "fad."

There are but few branches of engineering that have cost more in their development than machine hydraulics. This is due to the fact that builders, anxious to produce new features on their machines, withheld information from others until they were ready to market their product. Competitive builders spent comparatively large sums of money in developing the same thing simultaneously. Engineers experimented with the new "medium," going through all the grief and expense that their neighbors were experiencing, when a cooperative atti-

Fig. 4. The So-called "Slack Water Filling System" Employed for Operating a Press



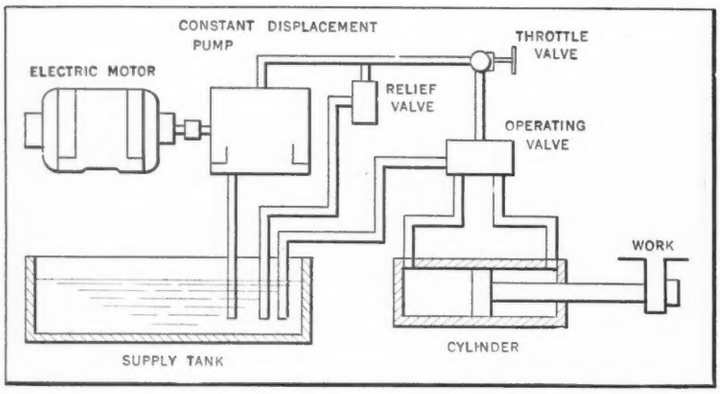


Fig. 5. The Throttling System for Obtaining and Controlling Hydraulic Motions

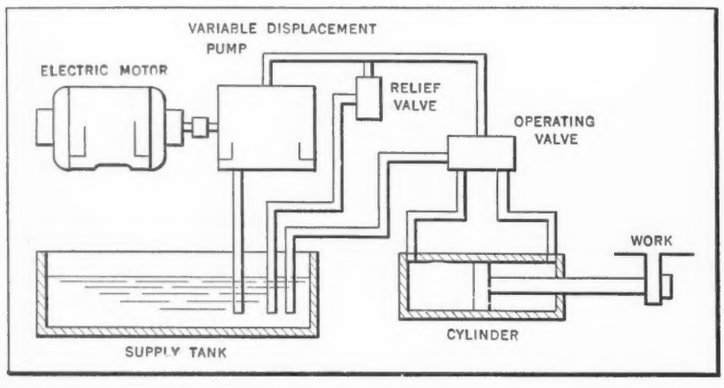
tude would have saved a large percentage of this development cost. Even today a number of firms are trying to apply hydraulics where they are not suitable, while others are still experimenting with fundamentals that are broadly known and accepted.

Early Applications of the Hydraulic Principle

The earliest known application of hydraulics was the water-wheel. It was used at first to lift water for irrigation purposes. For many years this system underwent practically no important change.

About a century and a half ago, the system of hydraulics was split up into two divisions, one utilizing natural head to produce rotary motion, and the other using a pump to produce reciprocating motion. The reciprocating system was applied to hydraulic presses, and the pump was driven by hand. This was followed closely by the power-driven pump. Soon presses were increased in size and capacity until they outgrew the pumping system. Attention was then concentrated on the pumping units, and some unique devices were developed. Since the press system required intermittent high pressures, and relief valves were poor or not available at all, early English engineers developed what was called an impact system, as shown in Fig. 1.

Fig. 6. The Variable-Displacement System for Controlling Hydraulic Motions



This system, which is shown diagrammatically, included a power-driven pump with a large flywheel and rather low power input, a press, and a stop valve. The valve was placed in the press discharge line. Ordinarily, this valve was open, the fluid being pumped through the system under just sufficient pressure to maintain circulation. To operate the press, the valve was closed suddenly, causing the pressure to be very rapidly built up by the stored energy in the flywheel of the pump. The pressure was released by merely opening the valve, allowing the fluid to circulate again at low pressure.

The impact system had certain drawbacks, however; pressures were uncontrollable, frequency of operation was limited, and there was always danger of the flywheel racing.

The Accumulator Principle Applied to Press Operation

This system was followed closely by the accumulator system. Such an arrangement is shown in Fig. 2. The pump is the same as is used in the impact system, except that no flywheel is necessary. The accumulator, which acts as a storage reservoir under pressure, consists of a cylinder of relatively large capacity and a ram. The cylinder is loaded with weights to obtain the desired hydraulic working pressure. The pump operates continuously, the excess fluid being pumped into the accumulator cylinder during the idle period of the press. This system is in general use today operating hydraulic riveters, flanging presses, forging presses, etc., but is not applied to automatic or semi-automatic machines, such as machine tools.

Later, for structural and economic reasons the hydraulic working pressures became excessive for the simple accumulator system described, and a new unit was introduced to build up the pressure at the press. This device is known as an intensifier. Its location in the system is shown in Fig. 3. The intensifier consists of two cylinders of different diameters, arranged in such a manner that the two rams are integral. It will be noted that the larger cylinder is connected directly to the accumulator line, while the smaller cylinder is connected to the press cylinder. It is obvious that should the larger cylinder be twice the area of the smaller, the unit pressure in the smaller cylinder would be twice as great as in the larger one. This allows a relatively low accumulator pressure and a high pressure at the press.

The advantages gained are that, the accumulator pressure being low, the pump and accumulator can be of economical construction, yet very high pressures can be obtained at the press with a small

amount of high-pressure fluid; the press cylinder size can also be reduced, effecting marked economy in the construction of this unit. Another advantage is the elimination of valves operating under high pressure.

The "Slack Water Filling System"

Many modifications of these systems have been developed. These include the steam-hydraulic system for high-speed forging presses and the pneumatic-hydraulic system for similar work. One system that is strictly hydraulic, yet involves a unique idea, is that known as the "slack water filling system" (see Fig. 4). This consists of a simple accumulator system to which is added a slack water tank above the press. The press is of the moving-down type. The purpose of this system is to reduce the volume of water handled under pressure, the cylinder being filled with water under atmospheric pressure, after which high pressure is applied for the final squeezing process. This system is very economical, since very little high-pressure water is required for very large press cylinders. The operating valves are interlocked so as to operate as a single valve.

As previously stated, the modern systems of industrial hydraulics are an outgrowth of the press idea, with certain developments for increasing the scope. Today, the use of cylinders is probably the most common application, but recently hydraulic rotary motors have been developed by which additional movements are obtained. With the addition of the rotary motor to hydraulic systems, a great many arrangements are possible, when operating in conjunction with a variable-displacement pump.

The Throttling and the Variable-Displacement Systems

At present, there are two general systems of hydraulics in common use, known as the throttling system and the variable-displacement system. There are two general divisions of each of these systems, in turn, depending on the results to be obtained, that is, reciprocating motion or rotary motion.

The simplest form consists of a power pump, control valve, and cylinder, the pump being of the constant displacement type, and the term cylinder including piston, rod and packing. Fig. 5 shows this arrangement, including also a relief valve and a throttle valve which, of course, are necessary for the complete system. This system is by far the most economical considered from the standpoint of first cost, but from the operating point of view, it should be noted that the power input is constant throughout the entire speed range of the system. Variable speed is obtained by throttling. The excess oil delivered from the constant-displacement pump is squeezed through the relief valve under operating pressure. Experience has shown that the maximum speed variation with this system is limited by the quantity of oil throttled and the pressure under which it operates. An excess of quantity and pressure causes heating and gasification, both of which are objectionable.

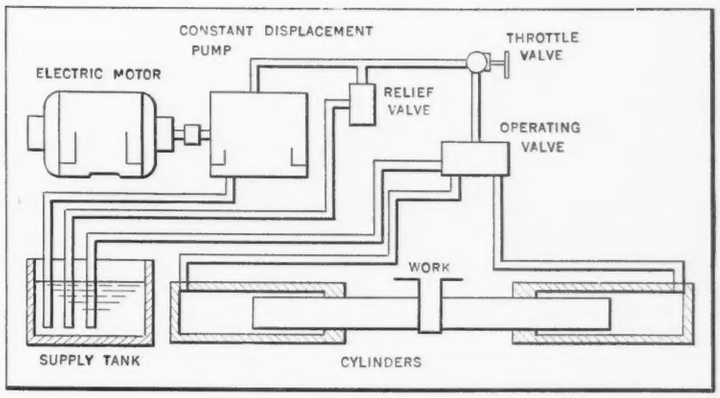
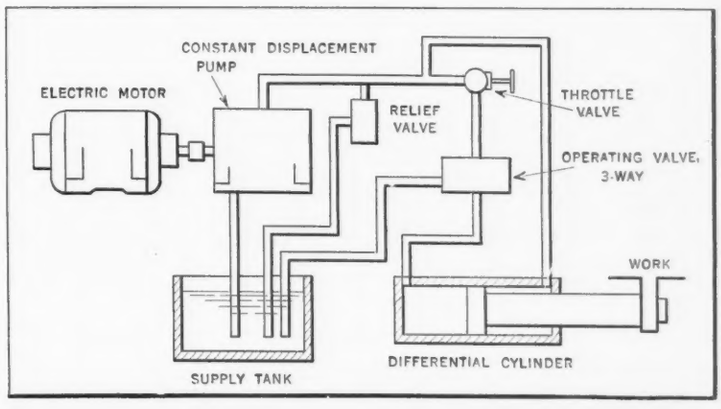


Fig. 7. Design that Facilitates the Construction of Cylinders and Eliminates Pistons

Fig. 6 shows the next step, which includes a variable-displacement pump, a relief valve (for protection only), an operating valve, and a cylinder. The throttle valve is omitted, as the quantity of fluid is varied directly at the pump. In this system, the power input varies with the displacement at constant pressure, so that there is an appreciable reduction in power input when a wide range of speeds is handled. The speed variation in this system is limited only by the maximum capacity of the pump, most variable-displacement pumps having a displacement range of from zero gallons per minute to maximum, depending upon the size.

The two types just described cover systems where reciprocating motion is desired. It is apparent that should rotary motion be required, con-

Fig. 8. A Hydraulic System in which a Differential Cylinder is Employed



stant-displacement hydraulic rotary motors could be substituted for the cylinders. The hydraulic characteristics would remain unchanged, and speed changes would be secured in the same manner.

Fig. 7 shows a modification of the design just outlined. All the units are unchanged, except the working cylinder, which is designed as shown to eliminate pistons, inside packing, and internal grinding. Fig. 8 shows the same system with a differential cylinder. It will be noted that the small area end of the piston is connected for constant pressure, thus eliminating a valve, while the large area end is controlled by a simple three-way valve. This arrangement is suitable for application to devices requiring a constant differential in speed, in opposite directions.

The four systems described in the foregoing are more or less basic. By modifying the units or introducing additional ones, an almost unlimited number of arrangements with different characteristics can be procured. Fundamentally, all existing hydraulic systems are modifications of these basic systems.

Owing to the interest that is being shown in incorporating hydraulic drives in the design of automatic and semi-automatic equipment, much thought has been devoted to the development of the units that make up the various systems. Pumps probably head the list, with hydraulic motors a close second. Since most positive-displacement pumps will operate as motors, if fluid under pressure is admitted at the proper connection, it follows that motor design is elementary modified pump design.

At the moment, there are several accepted designs of variable-delivery pumps. These pumps vary the delivery from 0 gallons per minute to the maximum capacity of the pump in both directions of flow, with but one direction of rotation. They are usually designed to operate at standard electric motor speeds, so that they can be direct-connected, thus eliminating gearing, chains, and belts. Hydraulic motors also embody the variable-displacement principle.

Usually variable-displacement pumps include a relief valve and an oil reservoir; when of the reversing type, the operating valve can be omitted. Throttling is unnecessary, as, since the pump is of variable displacement, the required speed range is provided for.

Basic Principles Governing Hydraulic Motion Designs

Hydraulics, like all other branches of science, are governed by definite laws. The output of a hydraulic power transmission is equal to the power input less certain hydraulic and mechanical losses. These losses are occasioned by leakage, mechanical friction, hydraulic friction, "wire drawing," and heat. Disregarding these losses and assuming 100 per cent efficiency, it will be noted that for constant power input, constant pressure, and constant displacement, the power delivery will be constant, the torque, however, varying with the speed of the motor, that is, high torque at low speed and low torque at high speed. This condition obtains where motor displacement is altered.

In considering a throttling system using a constant-speed, constant-pressure, constant-displacement pump, the power input will be constant, as a definite amount of fluid is pumped at a fixed pressure (controlled by the relief valve), regardless of the speed of the secondary unit (hydraulic motor), since the excess fluid at reduced motor speed is squeezed through the relief valve. The power delivered by the secondary unit, however, varies directly with the speed, the excess fluid pumped through the relief valve being a dead loss.

When a variable-displacement pump is used, the power input is directly variable with the volume at constant pressure. The difference between this system and the throttling system lies in the fact that no excess fluid is pumped under pressure, and the relief valve acts as a protection only, and not as a by-pass.

In the combination consisting of a constant-displacement pump and a variable-displacement motor, at constant pressure, the torque delivery will be constant, though the speed may vary, and the power input will vary as the power delivery varies.

Assuming that we have a hydraulic pump with a capacity equal to that of a hydraulic motor, it is found that with both units adjusted to maximum capacity, the speed of the motor will equal that of the pump.

With the same combination, by adjusting the capacity of the motor to decrease its displacement, the speed of the motor will be increased, while a decrease in the capacity of the pump will cause the motor speed to decrease also. In the first instance,

Comparison of Conditions in Hydraulic Systems

Power Input of Pump	Pump Speed	Pump Delivery	Pressure of Fluid	Motor Displacement	Motor Speed	Motor Shaft Torque	Power Delivery
Constant	Constant	Increasing	Constant	Constant	Increasing	Reducing	Constant
Constant	Constant	Decreasing	Increasing	Constant	Reducing	Increasing	Constant
Reducing	Constant	Constant	Reducing	Constant	Constant	Reducing	Reducing
Constant	Constant	Constant	Constant	Constant	Constant	Constant	Constant
Increasing	Constant	Constant	Increasing	Constant	Constant	Increasing	Increasing
Constant	Constant	Constant	Constant	Increasing	Decreasing	Increasing	Constant
Constant	Constant	Constant	Constant	Decreasing	Increasing	Decreasing	Constant

however, there is a limit to which the speed of the motor can be increased. This limit is governed by the mechanical construction, since, in theory, there is no limit to the attainable speed. The torque, however, decreases with the speed, and beyond the maximum speed for which it is designed, the efficiency decreases so rapidly that the entire power input is absorbed. Leakage causes a loss of speed in the secondary unit, while internal friction (both hydraulic and mechanical) causes a loss in power.

The accompanying table shows the general relationship between the various conditions of adjustment. It will be noted that the power delivery is always equivalent to the power input of the system (less frictional losses). With this combination, we are able to secure either constant torque at the hydraulic motor shaft or constant horsepower, but the pressure must be variable, if we are to secure constant horsepower with a constant displacement of the motor. Briefly, variable-displacement pumps produce constant torque, and variable-displacement motors produce constant horsepower.

In a system where the pump and motor are of the same maximum capacity, the lowest speed available by adjusting the motor is equal to the normal speed of the pump. In the same combination, the highest speed available is equal to the normal pump speed when the pump is adjusted. In all the foregoing considerations, friction and leakage have not been taken into account.

With the throttling system, only constant torque is available, and the power input is constant, as the excess fluid at reduced speeds is forced through the relief valve, due to the constant pressure.

How the Automobile Industry Avoids Patent Litigation

The automobile industry has frequently been acclaimed for its progressive patent policy. Patent litigation within the industry has been completely eliminated for the last seventeen years and unparalleled progress in automobile development has been made possible. The story of the progressive steps of the industry in patent matters is of remarkable interest.

Under the Cross-Licensing Patents Agreement of the National Automobile Chamber of Commerce, 136 companies, in 1914, contracted to exchange their patent rights for ten years without payment of royalty, each manufacturer contributing the patents he owned. More than 500 patents were included in this agreement. The members also voted to include all patents acquired either by invention or purchase from January 1, 1915, to January 1, 1925.

Provision was made for patents of a special or revolutionary character which were to remain the sole property of the member. It is to be noted, however, that not a single such patent was developed. Under this arrangement, and without one patent law suit among the members, 27,000,000 automobiles were built to a value of $24,000,000,000.

So successful was the arrangement that, upon its expiration in 1925, it was immediately renewed for five years. The new agreement, however, did not include new patents developed during the period 1925 to 1929; but another agreement was made in 1930 including all patents owned or controlled up to January 1, 1930. This agreement will be in effect until 1935 and includes over 1700 patents; 880 of these were taken out during the last five years. Patents taken out since January 1, 1930, however, remain the individual property of each manufacturer.

It is interesting to note what the results have been of this forward-looking policy. A survey of the patent situation by the General Motors Corporation shows that each General Motors car uses, on an average, seven patents owned by other members; and, in turn, other members use, on an average, seven patents owned by the General Motors Corporation.

As a result of this patent policy, royalties on patents used in present-day automobiles are of very small importance. It is estimated that these royalties amount to less than $2 a car. They are paid to companies who are not members of the National Automobile Chamber of Commerce or to individuals who have developed some new patentable idea.

* * *

There are over 1500 research organizations in the United States, and during the past year, industry has spent about $235,000,000 for their support.

Progress Made in the New Cutting Alloys

It is less than four years ago that the first announcement of tungsten-carbide tools was made in the United States. Yet in these four years, this new cutting alloy, along with other newly discovered tool materials, has completely changed the machining practice in a great many plants, especially in the electrical and automotive industries. May MACHINERY will review the present status of the steels and alloys used for cutting tools in American shop practice. Of course, nothing is ever complete or final, and new discoveries are constantly being made. However, the mechanical industries, must work with the knowledge at hand at any given moment; they cannot afford to wait until everything is known about a certain subject. Hence, May MACHINERY will record the progress made along these lines up to the present time.

Obtaining Better Results in Hardening High-Speed Steel

Prominent Manufacturers Have Found that the Hardening Methods Here Described Greatly Increase the Service Obtained from High-Speed Steel Tools

By WILLIAM E. SNOW

EQUIPMENT and methods employed in large plants for the heat-treatment of high-speed steel were described in March MACHINERY, page 486. The previous article dealt with the procedure in hardening high-speed steel tools and cutters up to and including the preheating operation. The present article takes up the procedure from that point.

Performing the Hardening Operation

The hardening furnace should be kept at a temperature not less than 2400 degrees F. for ordinary high-speed steels, and not less than 2450 degrees F. for steel containing cobalt. Some large commercial hardening plants operate their high-speed steel hardening furnaces at temperatures as high as 2600 degrees F.; but such furnaces have special linings designed to withstand this heat, which would quickly ruin the lining of the average furnace, as this is generally incapable of producing a temperature above 2450 degrees F.

Only one piece of steel is taken from the preheating furnace at a time and placed in the hardening furnace. The hardening furnace should have a small opening, just large enough to admit the work, instead of a door. The piece must be watched through the opening during the process of heating up to the quenching temperature.

The intensity of the heat radiated into the room makes the position of the hardener an uncomfortable one, especially with large furnaces, and it is advisable to provide a heat screen by stringing short lengths of close-linked chain on a wire stretched across the opening. This acts as a curtain against the heat without interfering with the view of the work, and may be readily pushed aside with tongs while the steel is being inserted and removed.

The steel must be watched carefully as it approaches white heat. The high preheat already given the steel and the high temperature of the hardening furnace cause the steel to take on heat very rapidly, especially in the case of small tools, where it is sometimes a matter of seconds rather than minutes before the tool reaches the quenching temperature.

As the tool nears the quenching temperature, small round globules of flux will appear on the surface. These globules increase rapidly in size and then start to spread; finally, if the steel is held too long in the furnace, they run together until the tool is dripping all over with the flux. This is commonly known as "sweating." The exact point at which to remove the tool from the furnace and quench it is determined by the appearance of these flux bubbles, and varies according to the type of tool being treated.

Tools that cannot be ground all over after hardening and those with thin teeth and thick bodies should be quenched at a point just short of that permissible for lathe and planer tools, in order to avoid slight pitting of the surface. Such tools should be removed from the furnace and quenched almost immediately upon the first appearance of the flux bubbles.

Lathe, planer, and similar less critical tools may be left in until the flux bubbles reach full size and just start to spread. If this action is correctly timed, the surface of the steel will have a mottled or very slightly pitted appearance, and it will be in the very best possible condition for performing efficient work. If the steel is held in the furnace beyond this point until the flux bubbles run together and flow freely all over the surface, the thin cutting edge of the tool will turn with the heat, the nose will be burnt and coarsened in structure, and the surface deeply pitted. This condition will necessitate long and tedious grinding before the tool can be used.

It is obvious that the exact determination of the proper quenching point of high-speed steel is a matter calling for some niceness of judgment. The correct hardening point cannot be determined with the naked eye at the high temperatures used. Colored glasses of green or blue, or some of the other tints sold for this purpose, must be used. In some of the larger hardening rooms, squares of colored glass in wooden frames are suspended in front of the furnaces for this purpose, the wood serving to prevent the face from being burnt through accidental contact with the frame. Such a shield enables the hardener to look into the furnace without undue eyestrain and determine the exact condition of the flux bubbles on the steel to a nicety that would be impossible without such equipment.

A little practice will enable one to harden high-speed steel with surprising accuracy by this method, and very few tools will be lost in the process. As the temperature at which the flux bubbles appear in the different brands and grades of high-speed steel varies directly with, and is consistently proportionate to, the analysis of the steel (mostly

in respect to the tungsten contained), any standard high-speed steel can be hardened successfully by this method without concern as to the actual temperature attained by the steel being treated. Hence, this method considerably simplifies the hardening process.

Much Depends on the Quenching Methods

The quench plays fully as important a part in the heat-treatment of high-speed steel as the hardening furnace. The "perfect quench" would be instantaneous and the product would undoubtedly be austenite, but it is impossible, of course, to obtain an instantaneous quench in actual practice. The quenching medium coming the nearest to effecting this ideal condition is extremely cold water, but the inability of the steel to stand such harsh treatment without cracking makes its use impossible. Therefore an oil quench is used, the cooling effect of which is less harsh, though slower in action. Unfortunately, this slower cooling allows more time for the formation of the softer constituents troostite and sorbite, along with martensite.

As the continuous quenching tends to heat the oil, it is necessary to provide means for keeping it cool. This is done by jacketing the tank and circulating around it a continuous flow of cold water. The cooling of the oil is an important point, but is frequently overlooked, quenching tanks in operation with the oil heated to the smoking point being no uncommon sight in many shops. Oil at a temperature above that of the hand is too hot for best results in quenching. Also old, burnt, thickened, or gummy oil does not make an effective quenching medium. The tank should be kept clean and the oil should be renewed at frequent intervals.

The quenching tank should be placed close to the hardening furnace, so that the distance the steel has to travel from the fire to the oil will be as short as possible. The point at which the steel has to be removed from the furnace for quenching is a critical matter of a second only; and as it is on a rising heat, even the few seconds required to carry it across the room to a remote tank are sufficient to prove detrimental for best results. This may seem to be drawing the line very fine, but it is a proved fact and should not be overlooked. It is the sum total of all these seemingly small points that makes for the best efficiency in the finished tool.

In quenching, the steel is removed from the furnace and plunged immediately into the tank, being thoroughly immersed in the oil, where it is swung to and fro with the tongs for a few moments to insure quick and even cooling. The steel may then be dropped on the rack at the bottom of the tank. A tool should never be quenched on the surface of the oil by immersing one end only, as this burns the oil and defeats the purpose of the quench. Always dip deep so that the work is entirely immersed. The oil at the bottom of the tank is the coolest.

Tempering or Drawing Operations

The tempering furnace should be kept at a temperature of 1000 to 1100 degrees F. for regular high-speed steels, and from 1200 to 1300 degrees F. for steels containing cobalt, depending on the type of tool and its use. These temperatures apply only to lathe, planer, and similar heavy-duty tools that frequently heat up to the point of visible redness while in operation. The tempering temperatures are intended to correspond with the maximum heat likely to be attained by such tools in severe service. They do not apply to milling cutters, forming tools, and similar tools for lighter duty, which are in some cases drawn at temperatures as low as 850 degrees. Drawing below 850 degrees, however, is not practical, as it leaves the tool too brittle.

In general, a tool should be drawn as near as possible to the highest temperature it will attain in actual operation —if above 850 degrees. If it is to be subjected to shocks in operation, a higher draw is necessary. Were it not for the certainty of producing cracks from surface-heating, we could allow the high-speed steel tools to draw themselves by the friction heat of the work itself.

The tool should be removed from the quenching tank as soon as it is cool enough to handle comfortably, and rolled in sawdust to remove the oil. It should then be wiped, placed in the tempering furnace, and soaked well until it has attained the full temperature of the furnace and an even heat penetration throughout. Next it should be removed to a dry place that is free from air drafts, and allowed to cool off gradually. Do not quench, as this tends to produce strains in the finished tool that may develop into cracks later under the friction heat of operation.

Care Should be Used in Grinding to Prevent Drawing Temper

Lathe, planer, and such tools should be ground on a dry wheel. If they heat up and have to be dipped in water to permit handling, they should be dipped frequently enough to keep them from getting so hot

Guaranteeing the Performance of Tools

"Tool manufacturers should not go blindly into the practice of guaranteeing performance," says C. B. Cole, president of the Tool Equipment Sales Co., in an article to be published in May MACHINERY. The practice of guaranteeing the performance of cutting tools has increased the cost of selling tools and tooling equipment considerably. This article, therefore, will be read with interest by manufacturers of small cutting tools and tooling equipment in general. Every manufacturer is anxious that his tools should give satisfaction; but this does not mean that where the conditions are unusual or experimental he should "hold the bag," without the buyer assuming any responsibility.

as to become injured. The combination of the heat, the friction of the wheel, and the cold water is very likely to start minute cracks in the cutting edge, which later cause premature breaking down of the tool unless caution is used in this regard. Also some grades of grinding wheels, unsuited to this class of work, sometimes produce similar results. When the steel becomes blue in grinding, it is an indication that the temperature is unsafe for water contact.

Tools Must be Annealed before Rehardening

Tools that sometimes show up as too soft after hardening must be rehardened. One of the most frequent mistakes made in the treatment of such tools is failure to anneal them before rehardening. In many cases, the tools are simply put back into the hardening furnace without any preparation. Any tool that has once been hardened must be annealed before it can be rehardened satisfactorily.

Anyone who doubts this can easily be convinced that it is true by taking two pieces of high-speed steel, hardening both, then annealing one of the pieces and rehardening both. After this has been done, nick and break the two pieces. The coarse fracture and dead appearance of the piece that was not annealed will tell its own story convincingly. A quick anneal, such as previously described, is all that is required to put such a tool into the proper condition for rehardening. This treatment is absolutely essential. In the case of milling cutters and forming tools of irregular section, a full anneal should be used.

Hardening Kinks for Special Requirements

Almost every hardener has certain "kinks" or tricks of his own for handling steel for particular purposes. These are little additional fine touches outside the usual routine work. Some of these kinks are good and useful on certain occasions, while others are of more or less doubtful value. The following have been tried out by the writer and found to serve a legitimate purpose.

Forgings and castings occasionally have surfaces so hard that they break down the tool, making machining very difficult, if not impossible. In such cases, a tool of extra hardness is helpful, and it may be prepared by one of the following methods, either by making a new tool or rehardening an old one.

Cyanide Treatment—Treat as usual in a furnace, but just before the tool reaches the quenching point, reach into the furnace with a long-handled borax spoon and pour about a thimbleful of cyanide of potassium on the point of the tool; then quench immediately in oil as usual. See that the handle of the borax spoon is a long one—two feet at least—for cyanide is no respecter of persons and spatters viciously when applied to hot steel, producing severe burns if it comes in contact with the skin.

Boracic Acid Treatment—A little-known kink, which is quite useful in its way, is the application of boracic acid for protecting the surface of the steel in hardening milling cutters and forming tools, where freedom from decarburization and the preservation of a fine surface are especially desired.

To use this method, first obtain two or three pounds of powdered boracic (not boric) acid as chemically pure as possible, and spread on a metal plate near the preheating furnace. Wet the tool to be hardened in water to make the acid stick on, and roll in the powdered acid until well coated. Then place the tool in the preheating furnace and treat as usual. When at full preheat, remove the tool, roll thoroughly again in the acid, then place in the hardening furnace, and treat as usual.

When the tool is quenched in the oil, most of this coating of acid will scale off; the rest can be scraped off, leaving the tool bright and with the surface in the same condition as when it went into the preheating furnace, so that there is no necessity for grinding. The only drawback to the use of boracic acid is its tendency, unless chemically very pure, to stick tenaciously to the surface of the steel after the quench, this being more apparent with some steels than with others.

On this account its use on tools like taps, having small teeth close together, is not to be recommended, as it tends to burn itself into the small spaces between the teeth. Sometimes it is almost impossible to remove this burnt-in substance, but a little careful experimentation on a few pieces of work will readily determine its usefulness and its limitations on any particular class of tool.

Locating Hardening Troubles

Troubles, except those due to imperfections in the steel itself, can generally be traced to a definite cause. The troubles most frequently encountered in hardening steel and their possible causes are as follows:

Softness—Steel underheated; furnace not up to proper temperature; quenching oil too hot; tempering done at too high a temperature; carbon content of steel too low.

Cracking—Careless forging; steel not annealed after forging; too rapid and uneven heating; too harsh a quench—oil too cold; steel allowed to chill before tempering; steel not tempered soon enough after hardening (this should be done as soon as possible, especially with milling cutters and forming tools); steel checked in grinding; steel rehardened without being annealed.

Warping and Shrinking—Steel overheated; quench too sharp; steel heated unevenly.

Excessive Decarburization—Steel overheated; gas mixture in furnace too lean; air leaks in roof or walls of furnace; steel soaked too long in furnace.

* * *

A special locomotive, capable of making only twenty miles an hour, has been built to haul the dirigible *Akron* in and out of her hangar. The locomotive was designed to travel at slow speed, in order to prevent any jerking or straining of the airship while it is being hauled along the ground.

What the X-Ray Tells About Castings

X-Ray Pictures of Castings Lead to Improved Foundry Practice

By RICHARD K. AKIN, Research Metallurgist
The Robert W. Hunt Co., Chicago, Ill.

ONE of the most important industrial applications of X-rays has been in foundry practice. Pattern designs, molding methods, and melting practices are frequently the cause of shrinkage cracks, cavities, and blow-holes that are not apparent on the surface, but that may cause failure after the casting has been placed in service.

Through the use of radiographs or X-ray pictures, defects such as these can be detected and measures taken to eliminate them. Whenever a large lot of castings is to be made from a new pattern, it is wise to X-ray the first castings completely. Defects can then be eliminated on subsequent castings by changing the location of gates and risers, pouring at the correct temperature and at the right rate, improving the melting practice, etc.

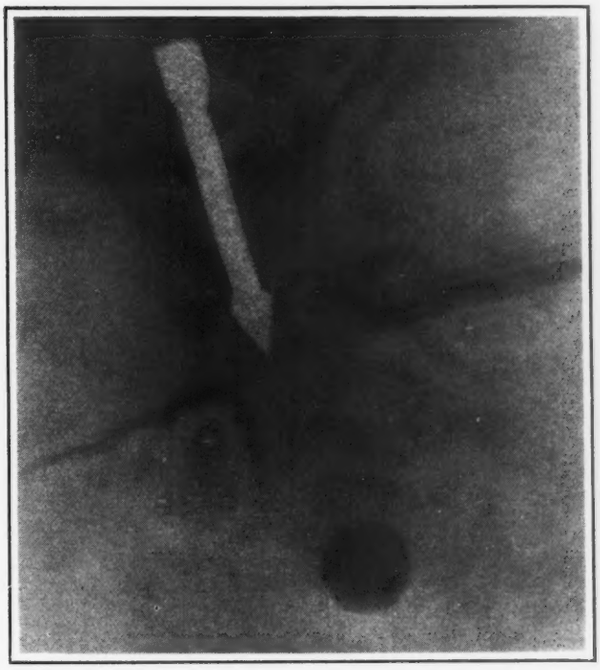


Fig. 1. X-Ray Picture that Shows a Large Crack and a Blow-hole in the Casting

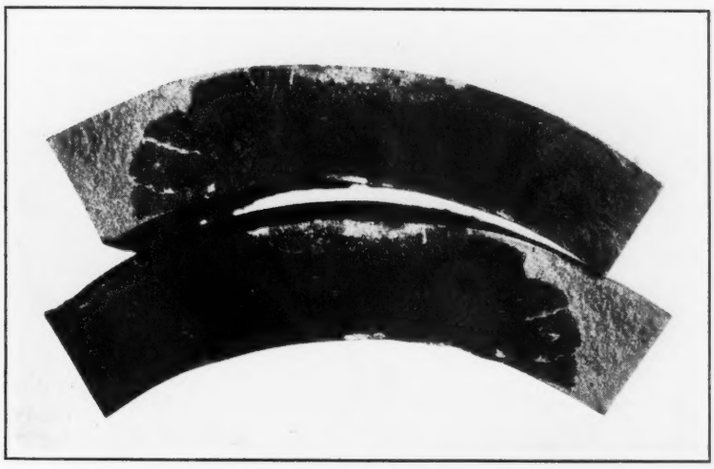


Fig. 2. Broken Sections of a Steel Casting that Show the Extent of the Crack Indicated by the X-Ray Film

Fig. 1 shows an X-ray picture of a steel casting taken in the laboratory of the Robert W. Hunt Co., Chicago, Ill. A lead arrow was placed at random on the casting to serve as a means of locating any defects that might be shown by the film. X-rays do not readily pass through lead, and so the arrow shows up distinctly.

When this X-ray film was developed, it was found, curiously enough, that the arrow pointed directly to a crack that extended practically through the wall of the casting, except for a thin skin along the outside. This crack had not been visible to the naked eye. It had developed around

Fig. 3. An X-Ray Photograph of Part of a Propeller Blade which Indicates that "Freezing" of the Metal Began before the Mold had been Completely Filled

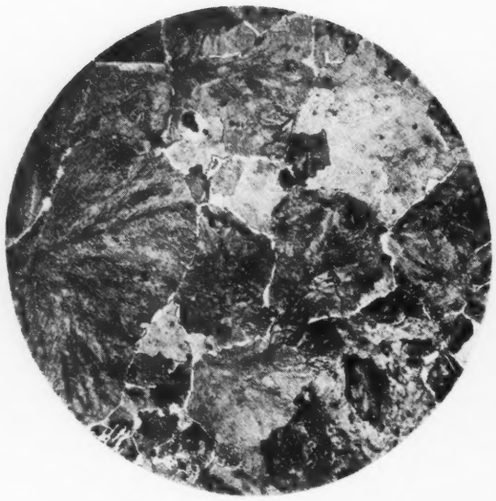


Fig. 4. A Photomicrograph Taken in Order to Examine the Metal in the Vicinity of the Blow-hole

a chaplet, the post of which is seen as a circle just at the right of the arrow point. The square formed by the indistinct lines is the chaplet base. Beneath the arrow and the chaplet, is a black circle which indicated a blow-hole. Smaller defects were indicated by dots.

In order that the nature of the defects could be studied visually and microscopically, the casting was broken into two parts along the line of the crack. From Fig. 2, it will be apparent that, in the casting operation, the metal did not fuse around the chaplet, perhaps because of too much moisture in the mold and too low a pouring temperature. The large dark areas noticeable on these casting halves indicate where the crack existed.

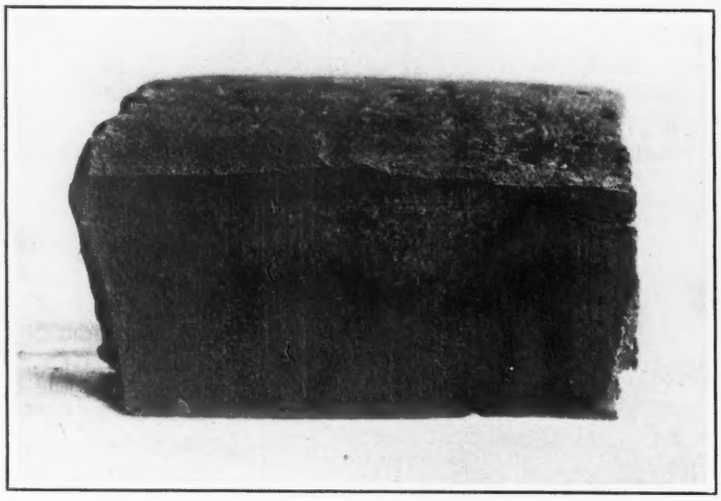


Fig. 5. The Casting was Sawed through in Order to Determine the Nature of the Blow-hole Shown in the X-Ray Film

By reference to the X-ray film, the location of the blow-hole on the casting was next determined, after which the casting was sawed through, as illustrated in Fig. 5. The blow-hole and the sponginess in its immediate vicinity indicated the presence of dissolved gas during the casting process, caused by improper melting practice. Also, slag in the blow-hole suggested that the metal was particularly dirty.

The casting had undergone an annealing treatment and the metallurgist decided to find out what the effect had been. Thus the specimen shown in Fig. 5 was polished and etched, and the photomicrograph illustrated in Fig. 4 was taken of the metal in the vicinity of the blow-hole. This photomicrograph, by its large crystals, showed that the metal had not been properly annealed at this portion of the casting, which was due partly to the dirt and partly to other conditions.

X-ray pictures of castings believed to be of the highest grades often disillusion foundrymen. Fig. 3 shows an X-ray picture of a portion of a cast-aluminum airplane propeller that was considered a good casting. Toward the left end, the film shows that "freezing" of the metal started before the mold had been completely filled. By changing the gates and risers, and adjusting the pouring temperature and rate of pouring, a more homogeneous casting was obtained.

Assembled units can also be X-rayed for inspection purposes, as will be seen from Fig. 6, which shows a complete globe valve, all parts of which are made of brass. The film shows no defects in any part.

The examples recorded indicate the important part that X-ray pictures may play in the inspection of castings. By their use, hidden defects are revealed and unsuspected weaknesses become apparent.

* * *

An indicator is manufactured by Vickers-Armstrongs, Ltd., Dartford Works, Kent, England, for automatically recording the safe load on cranes. In England, many cranes used in engineering operations are required by law to be provided with such automatic safe-load indicators.

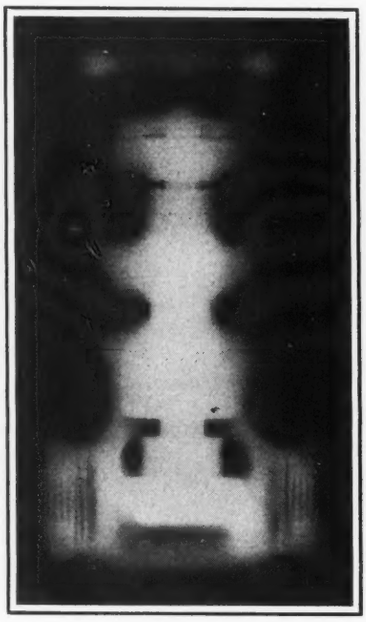


Fig. 6. An X-Ray Film of an Assembled Globe Valve that Shows the Casting to be Free from Defects

An Ingenious Assembling Die

By EUGENE L. SOLTNER, Philadelphia, Pa.

The accompanying illustrations show a die that was designed and built for assembling, or securing in the assembled state, the pieces *A*, *B*, and *C* shown in Fig. 1. The die produces the small lugs *S* on the pin *A*, which serve to hold the part *C* in place under the tension of spring *B*.

The die consists of the die proper *D*, punch *E*, leaf *F* with its locking spring, arm *G* with handle attached, retaining screw *H*, and anvil *J*. Arm *G* is bored at one end to receive the work and at the other end is hinged to leaf *F* on the pivot pin *T*. By means of the attached handle, this arm can be moved into and out of position for the insertion and removal of the work.

While in the working position, arm *G* is secured in the slot in leaf *F* and is locked in position by the spring *K*. The bracket *L* is fastened to the bolster and the leaf *F* is secured to the bracket by a hinged connection. Leaf *F*, therefore, is free to move up

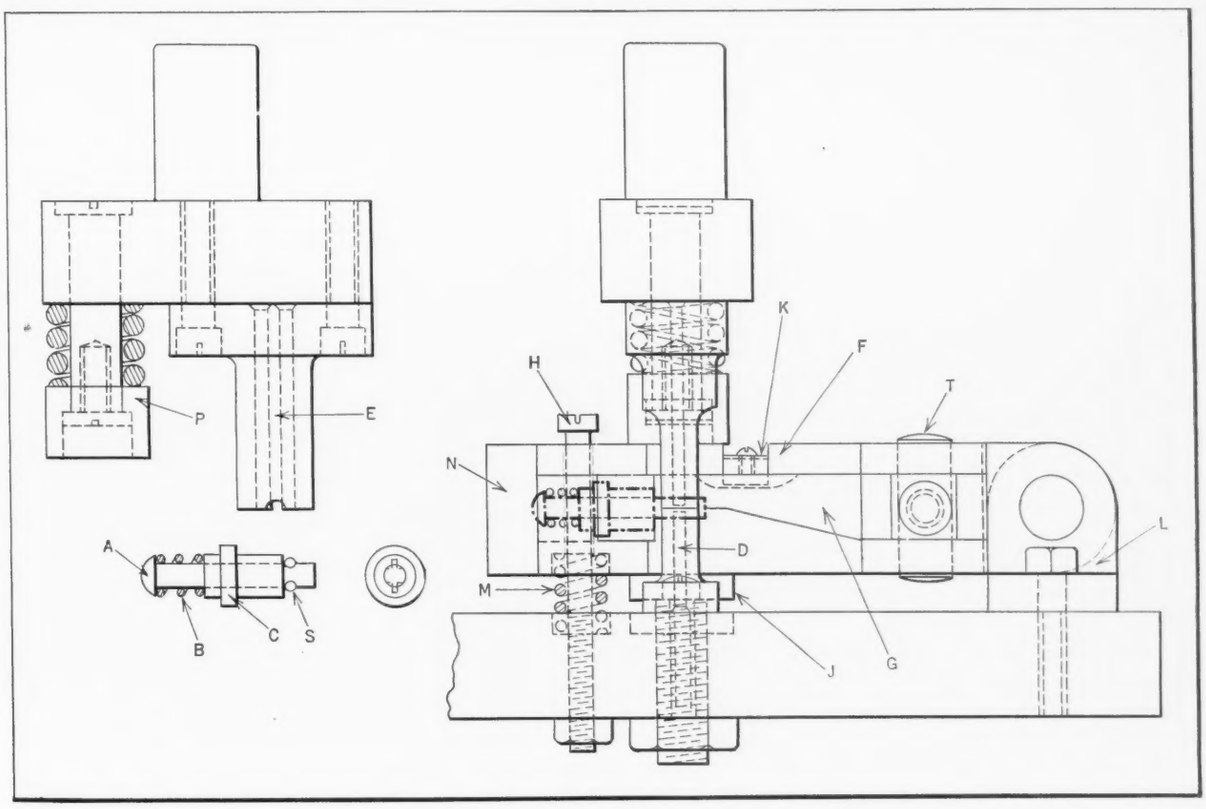


Fig. 1. Die for Compressing the Spring B and Forming the Assembly-retaining Lugs S

and down, the amount of movement being governed by the retaining screw *H* and anvil *J*. Normally, leaf *F* is held in the up position by the spring *M*. This lifts the piece out of the die upon the completion of the work, and permits the next piece to be swung into position without any interference.

When in use, the die is operated as follows: The operator places spring *B* on pin *A*, and then slips the bushing *C* over the two parts. The assembly is now placed in the counterbored hole in arm *G*. As the arm is moved into the closed position, pin *A* comes in contact with the face of the projection *N*. This forces pin *A* into the proper position. At this point the head of pin *A* snaps into the slight depression in piece *N* and the locking spring *K* snaps into the slot in arm *G*. The operator then trips the press. As the ram descends, the pressure pad *P* on the punch forces the leaf *F* down against the anvil, bringing the work into the proper relation with the die for crimping or forming the lugs *S*. On the return stroke, the spring raises leaf *F*, carrying the work out of the die.

Originally the face of piece *N* was made without the slight depression shown. However, it was found in practice that when this was not provided, the tendency was for pin *A* to drag, due to resistance and the necessary amount of clearance between the pin, the bushing, and the hole in arm *G*. This caused the work to tilt, resulting in a job which, while passable, did not have the finished appearance desired. When the depression in *N* was provided, the head of the pin, upon coming to the edge of this spot, would snap into the depression, bringing the assembly at right angles to the die. This die proved to be rapid, as well as safe to operate.

Bevel-Gear Testing Fixture

By PHILIP F. SHAFRAN, Machine Design Instructor
James Monroe High School, New York City

The fixture shown in Fig. 1 is used for testing the accuracy and concentricity of the teeth in bevel gears, such as shown at *X*. This gear is an integral part of a shaft about 12 inches long, and is located in the fixture by slipping the shaft through the bushing *K*. The portion of the shaft immediately below the gear is finished for a ball-bearing seat and therefore provides a locating surface that is accurately finished to a given diameter. Thus, the gears are all uniformly and accurately positioned for gaging the teeth. Clearance for the long shaft is provided for by cast-iron legs, indicated at *Z*.

The fixture consists primarily of a body casting *A* and a hardened steel slide *B*, which slides in the ways cut in casting *A*. Slide *B* is held down by hardened strips *C*, and has mounted on it the small casting *E* which provides a seat for the dial gage *D* and the ball-shaped contact point *F*. The ball *F* is made the correct diameter for gaging the width of the tooth space on the pitch line. By constructing the gage with an auxiliary contact *F*, little or no strain is put on the indicator *D*. The ball point *F* is held in the hardened and ground bushing *G* and is pressed forward by a light coil spring. Set-screw *H* engages a slot in the body of point *F* and holds it in the bushing *G*.

Engagement and disengagement of point *F* is accomplished by handle *L* acting through levers *I* and *J*. Lever *I* is pinned to the shaft *S* to which lever *L* is also pinned. Lever *J* is free to turn on shaft *T*, but is held in the lower position, that is,

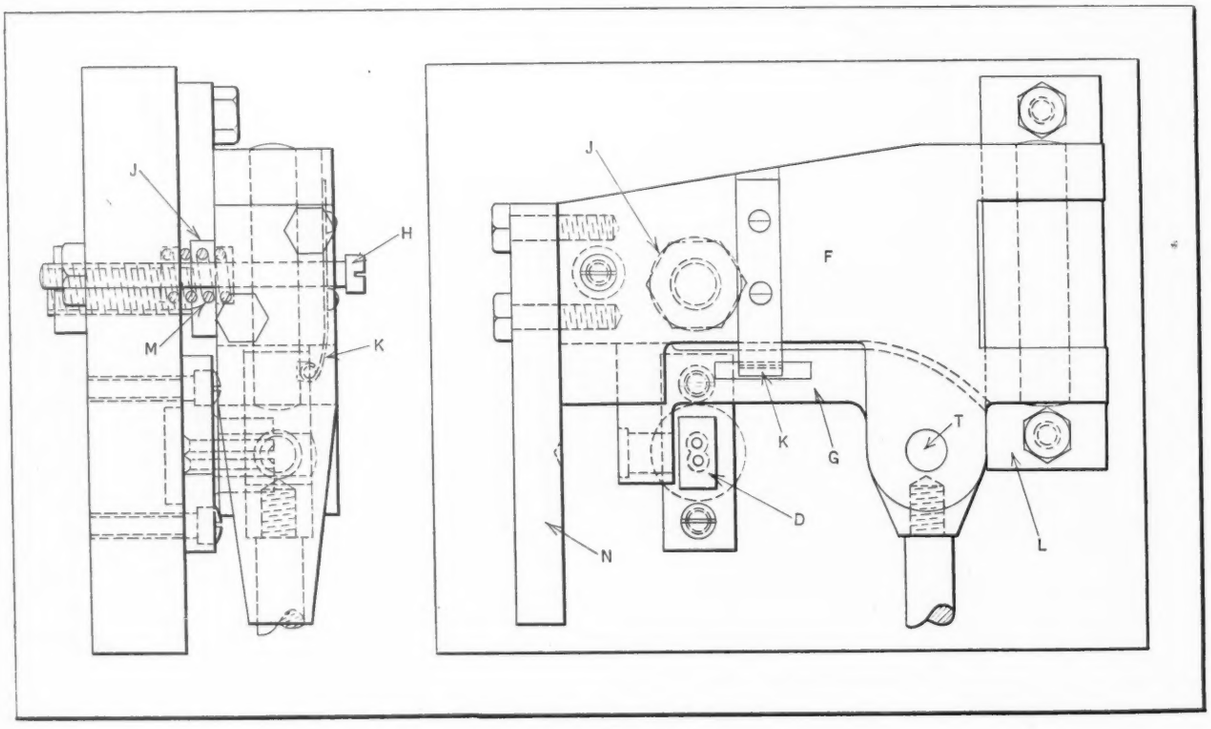


Fig. 2. Plan and End Views of Die Member Shown in Fig. 1

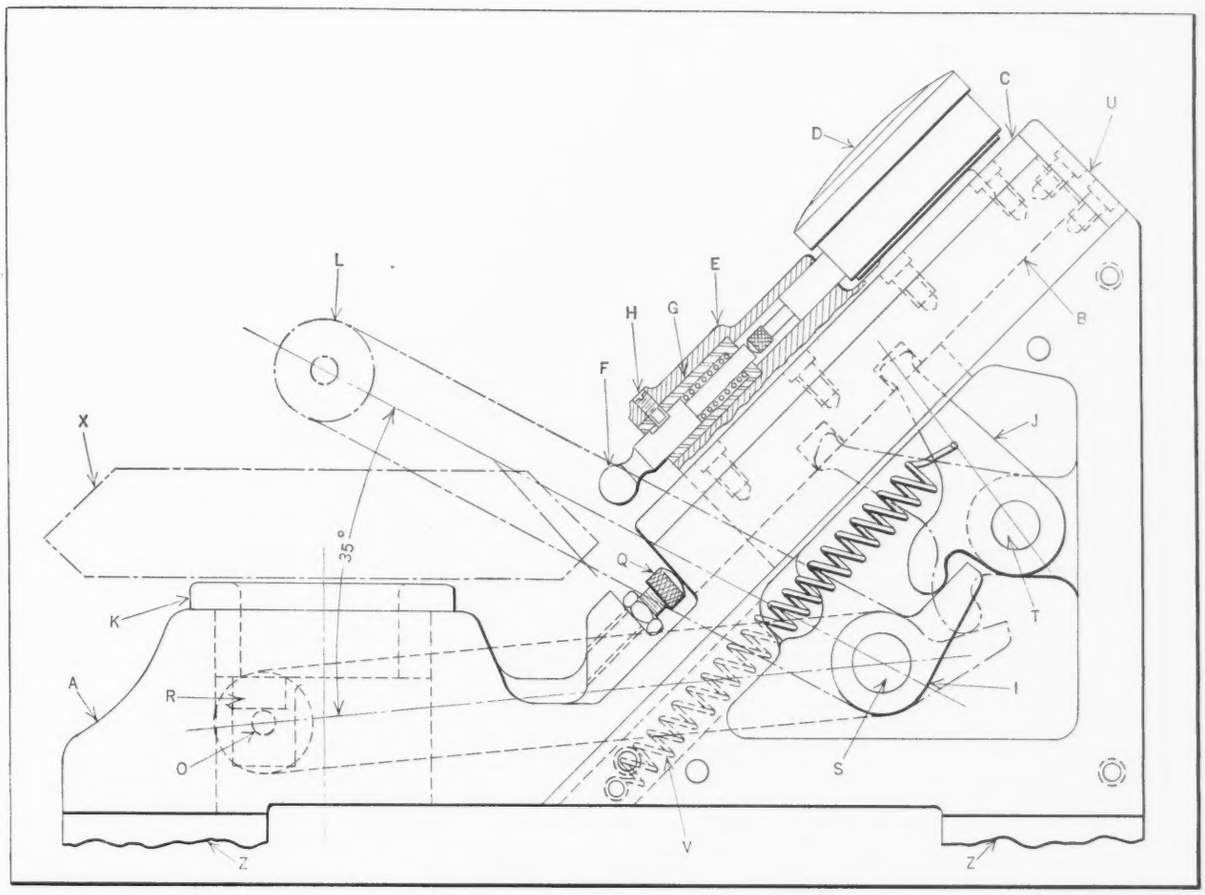


Fig. 1. Fixture for Testing Concentricity of Bevel Gear Teeth and Width of Tooth Space on the Pitch Line

in engagement with lever *I*, by the tension coil spring *V*. The stop-screw *Q* serves to locate or stop the slide *B* in the lower or gaging position. The upper end of lever *J* engages the slot in slide *B*, causing the slide to move with the lever. A cover plate (not shown) is provided to cover the triangular opening that houses the levers. This plate provides additional bearings for shafts *S* and *T*. The back plate *U* is a cold-rolled steel strip which limits the upward motion of slide *B*. Slide *B* moves in a path perpendicular to the pitch line of the gear.

The fixture is used essentially as a comparator. A master gear is used in setting the indicator, after which gears to be tested are compared with the readings taken for the master gear. The amount of error is easily read on the dial indicator *D*.

The operation of the fixture is as follows: Lever *L* is brought down to the lower position, turning lever *I* counter-clockwise. Lever *I* turns lever *J* clockwise, which serves to raise slide *B* and the indicator to the upper or disengaged position. Lever *L* is held in the lower position by means of the spring-actuated pin *O*, Fig. 2, in the handle of lever *L* and the latch *R* on the base of the fixture. This arrangement leaves both of the operator's hands free to load the fixture.

By pulling the knurled handle *N* outward, pin *O* will clear latch *R* so that lever *L* is free to resume its upper position and thus bring the slide indicator into the testing position. The gear to be tested is turned until a tooth space is in line with the ball contact point *F*, Fig. 1, before permitting the slide to come down to its lowest position. All the tooth spaces in the gear are tested in this way, the complete operation requiring only a few minutes.

The construction of the handle of lever *L* containing the stop-pin *O* is shown in Fig. 2. The pin *O* is a free fit in bushing *M* and is normally pressed forward by a light spring placed behind a shoulder on the pin. Pin *O* is retained in the bushing *M* by means of pin *P*, which is a tight fit in pin *O* and engages the elongated slot on both sides of bushing *M*. The knurled sleeve or handle *N* is placed in position before the pin *P* is driven into place. A small hole (not shown) in handle *N* provides means for inserting pin *P*. An annular groove in handle *N* allows clearance for the pin, this groove being wide enough to permit pin *O* to ride over the beveled edge of latch *R* without changing the position of handle *N*. When disengaging pin *O*, the shoulder of the groove engages pin *P*, thus withdrawing pin *O* from contact with latch *R*.

A universal tester or comparator can readily be designed along the lines of the one illustrated. In fact, the original gear-tester designed by the writer could be used on a variety of bevel gears. It could also be used for checking spur, spiral, and worm gears. An adjustable locating point for the gear

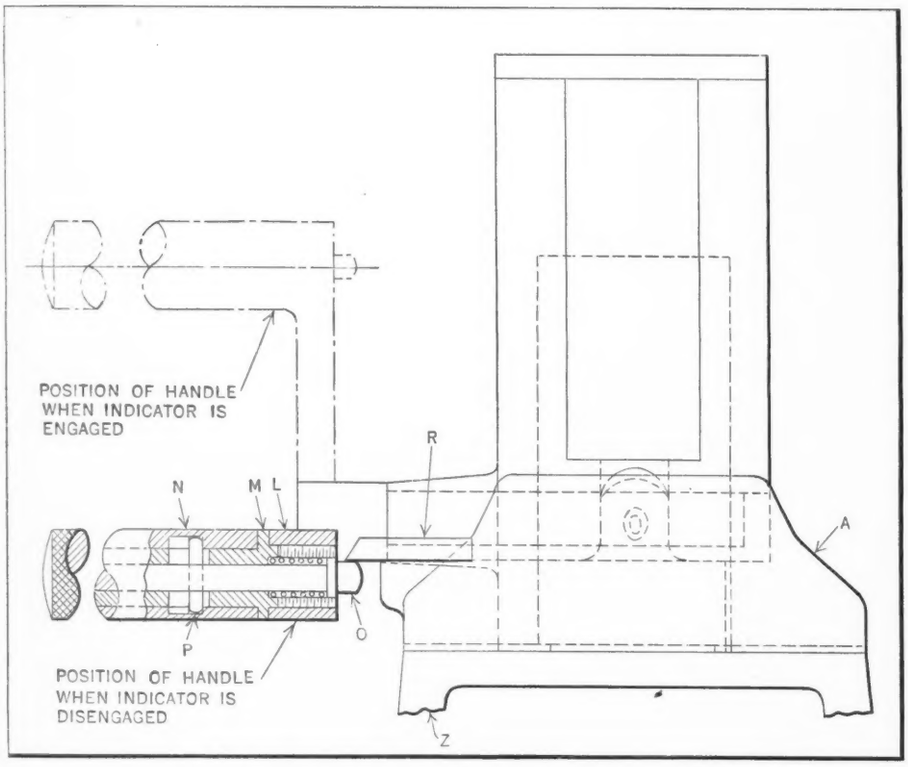


Fig. 2. End View of Fixture Shown in Fig. 1, with Cross-section of Operating Handle

and several sizes of pins *F* were provided in the original design. However, the customer insisted on having single-purpose fixtures, claiming that sufficient quantities of gears were being made to keep the fixtures in constant use.

Jig for Drilling and Tapping Radial Holes

By WILLIAM C. BETZ, Master Mechanic
The Fafnir Bearing Co., New Britain, Conn.

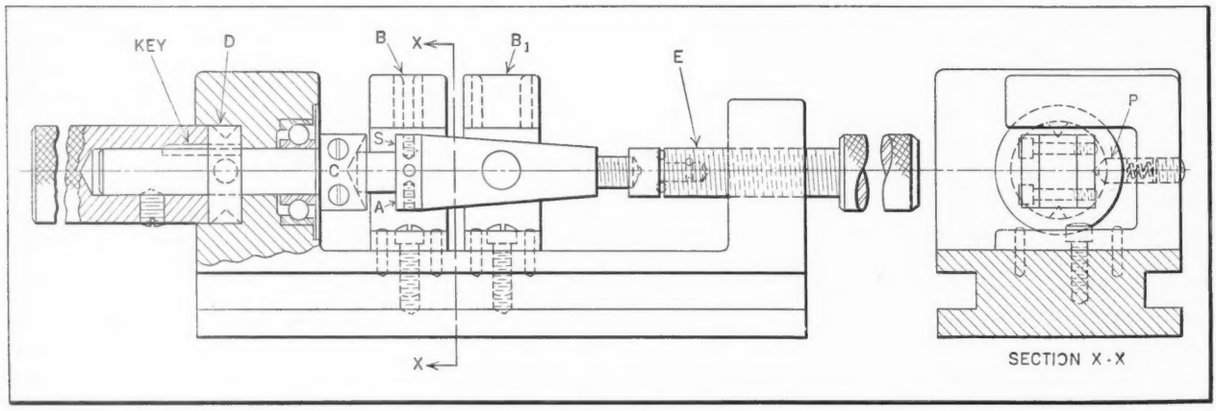
The combination drilling and tapping jig illustrated was made to accommodate a complete series of taper plugs for stop and waste cocks used on pipe lines. Three changes in block *C* and the drill bushing brackets *B* and B_1 serve to cover the range of sizes handled. One of the taper plugs is shown in the jig at *A*. The pieces are first turned, faced to length from shoulder *S*, threaded, and straddle-milled to give a square shank. Next, the pieces are placed in the fixture, which is strapped to the table of a sensitive drill press for the radial drilling operations. After all the pieces are drilled, the fixture is turned on its side for tapping the holes with a small tapping fixture mounted in the drill spindle.

As three sides are drilled and tapped, the indexing disk *D* has three indexing spots on its face. In putting the work back into the fixture for the tapping operation, the operator must be sure to place the piece so that the odd hole faces to the front when the letter C on the shoulder bracket also faces to the front. The work is fastened in place by the tailstock screw *E*. The combination radial and thrust bearing at the opposite end takes the thrust of block *C*. The indexing is done with the left hand, leaving the right hand free to operate the spindle lever of the machine and the tailstock screw. The ball-end locking pin *P* and the indexing disk *D* are hardened.

Wire-Forming Die with Slides Operated by Wedge Plates

By S. A. McDONALD, Brooklyn, N. Y.

The forming of wire pieces such as that shown at *A* in Fig. 1 is usually done in an automatic wire-forming machine. If there is not sufficient work



Indexing Jig for Drilling and Tapping Radial Holes

of this nature to warrant the purchase of a regular wire-forming machine, the pieces can be made in a punch press with a die like that shown in Figs. 1 and 2.

The die consists of a bolster *S* in which are located the three slides *B*, *C*, and *D*, the forming pin *E*, and the two locating pins *F* and *G*. The slides carry the forming tools *H*, *J*, and *K*, and the springs *L* that keep the slides away from the forming pin while they are not in operation. These slides are fitted to T-slots in the bolster and extend upward to form wedges or cams. Passing through the forming pin is a knock-out *Q* consisting of two pins in a pad, its movement being limited by a stop-pin *R*.

The upper half of the tool consists of the holder *M*, Fig. 1, which is located in the ram of the press, and the three wedges *N*, *O* and *P*. In operation, a wire previously cut to length is located between the pins *F* and *G*, Fig. 2, by means of a magnetized bar of flat stock. This bar is used to pick up the wire and place it in position in order to eliminate the necessity for placing the hands in a hazardous position under the punch member. When the wire is in position, the press is tripped.

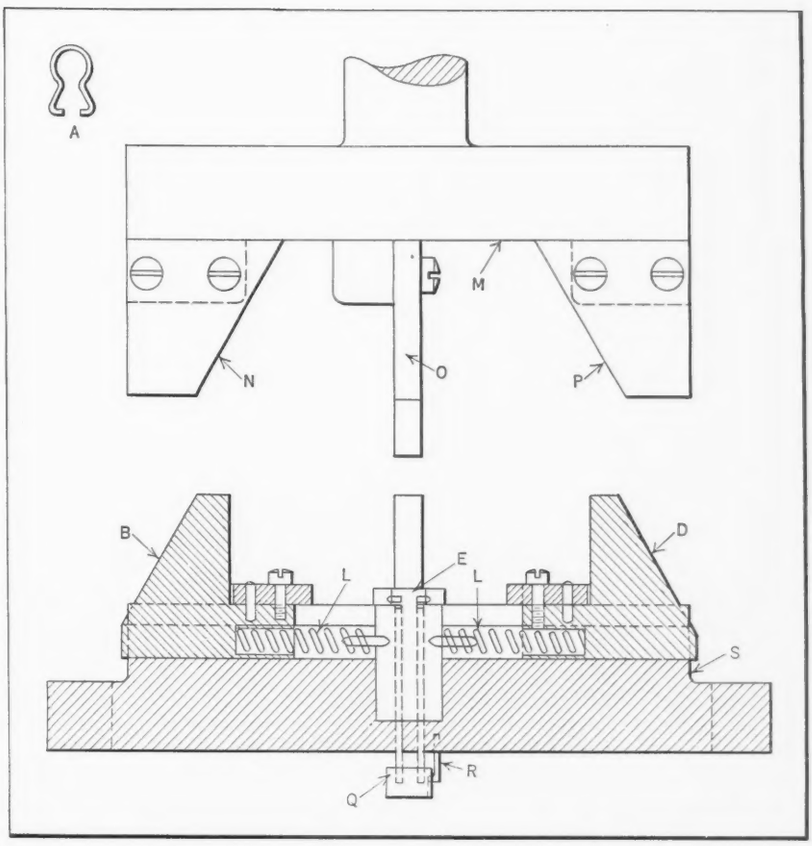


Fig. 1. Die with Three Wedge-operated Slides for Forming Wire Part A

As the ram descends, the long wedge *O*, Fig. 1, forces the slide *C*, Fig. 2, inward so that the forming tool *J* carries the wire against the pin *E*, bending it to a U-shape around the pin. The straight portions of the wedges *O* and *C* are now in contact, and hold the wire in this position while the wedge plates *N* and *P* make contact with the wedges on slides *B* and *D*. Continued downward movement causes the slides *B* and *D* to form the wire to its final shape. Slides *B* and *D* give the work a final squeeze that sets the wire so that it will not spring out of shape when the pressure is released.

As the ram ascends, the slides move out under the pressure of the springs *L*. When the upward stroke is finished, the operator pushes out the knock-out by hand, so the two pins hold the wire clear of the forming pin. As the press is inclined backward, the formed wire piece falls into a box at the back of the press. Five thousand pieces are

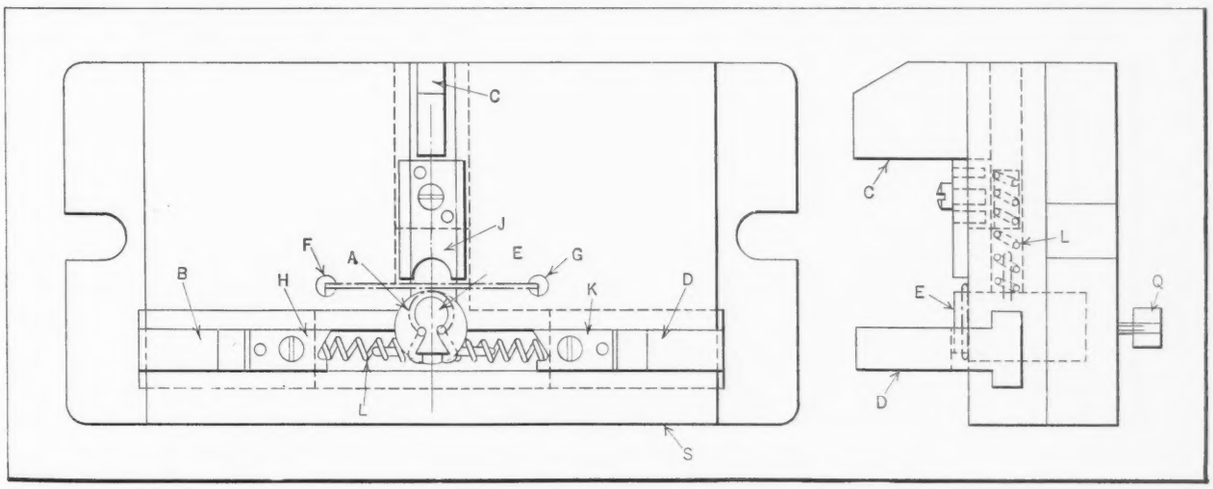


Fig 2. Plan and End Views of Die Member Shown in Fig. 1

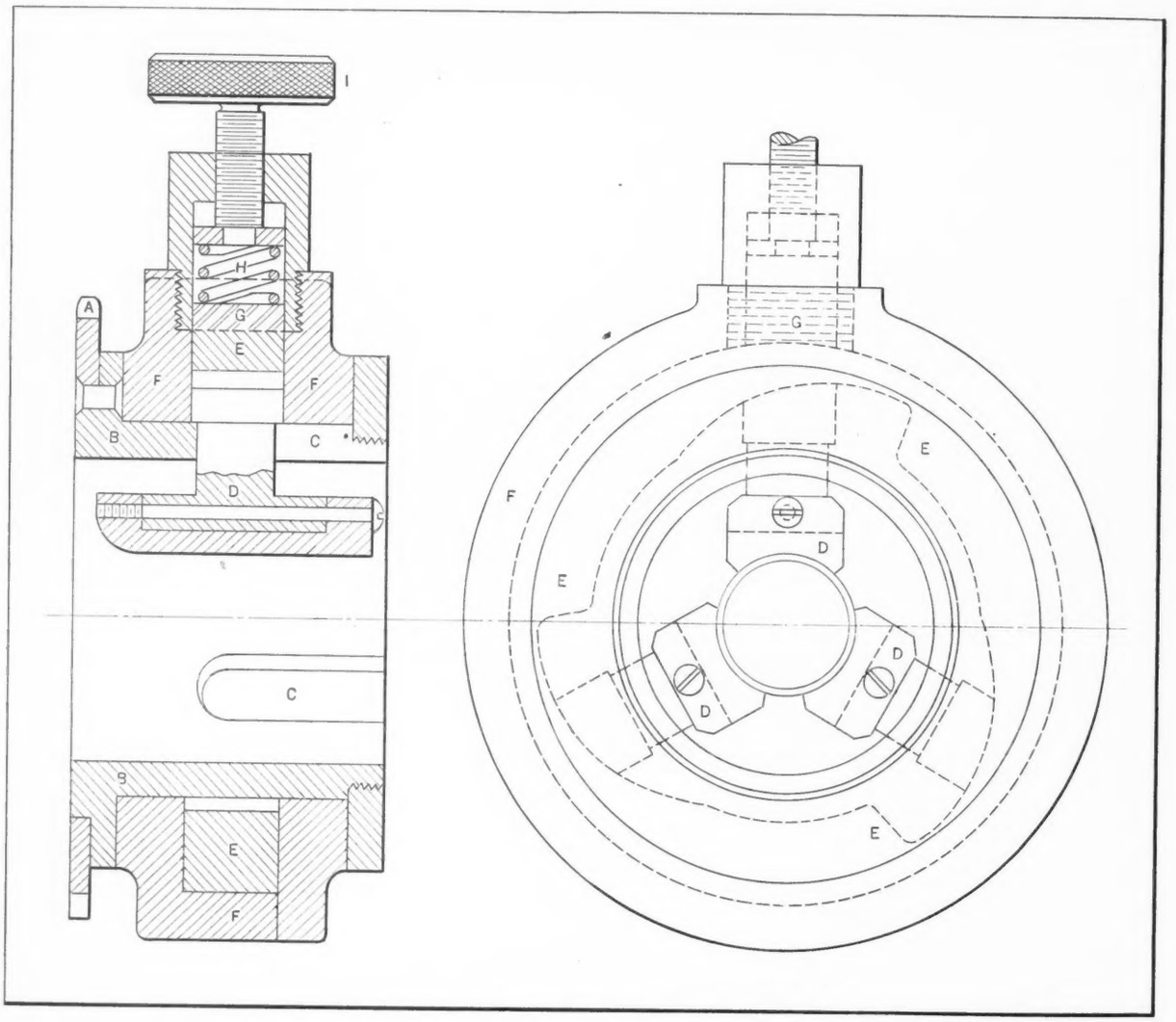
formed by this die, on an average, in an eight-hour day. By changing the forming pin and forming tools, wire pieces can be formed to other shapes.

Self-Gripping Chuck

By R. A. PERRETT, Chicago, Ill.

A self-gripping chuck for gripping locomotive bushings on the inside was described in August MACHINERY, page 946. Another self-gripping chuck of the cam-operated type is shown in the accompanying illustration. The chuck here illustrated was designed by the writer for gripping or holding round stock. Referring to the illustration, the drive sprocket *A* is riveted to the hollow sleeve *B* in which there are three slots *C*. In these slots are the jaws *D*. Around the jaws is an internal cam *E*. The whole assembly is free to revolve in the housing *F*. The cam is restrained from revolving by the brake-pad *G*, the pressure of which can be adjusted by means of the thumb-screw *I* and spring *H*.

The stock is placed in the expanded jaws, and the sprocket and sleeve start revolving. This causes the jaws to revolve and slide over the cam surfaces which force them inward against the outside of the stock. When the jaws are tight against the stock, the cam starts revolving, the tension exerted by the brake-pad being overcome. This device was originally designed to make only 1 1/4 revolutions of the stock and then reverse for releasing the stock. The design could be changed to permit the work to make more revolutions, but if this were done, the brake would, of course, wear faster and require more frequent adjustment. Stock of different diameters can be accommodated by providing interchangeable jaws of different sizes.



Self-gripping Chuck of the Cam-operated Type, for Holding Bar Stock

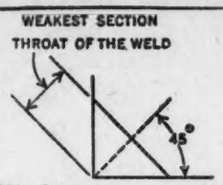
* * *

The motorcycle industry suffered less in 1931 from the business depression than any other group in the automotive field. It is stated that the industry expects a satisfactory volume of sales during the present year.

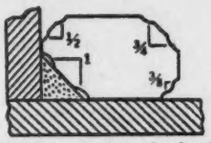
MACHINERY'S DATA SHEETS 223 and 224

ARC-WELDING INSTRUCTIONS*—5

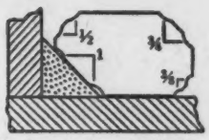
Welding Gages Made by Westinghouse Co. to Gage Welds as Recommended by American Bureau of Welding



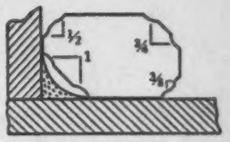
(30) Location of weakest section in weld.



(31) Gage shows 1-inch fillet weld of correct size.



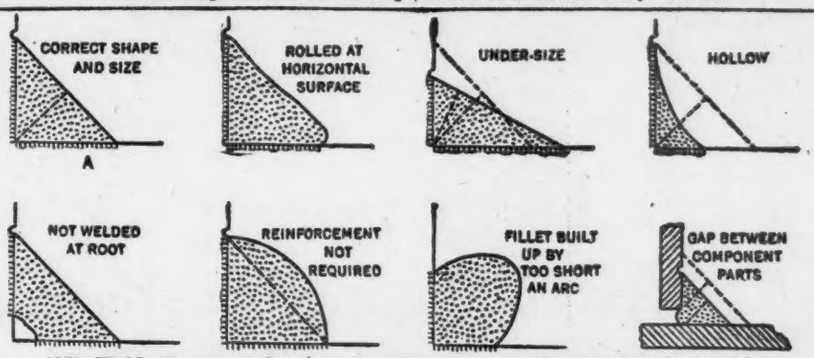
(32) Gage shows fillet weld to be over-size.



(33) Gage shows weld to be under-size.

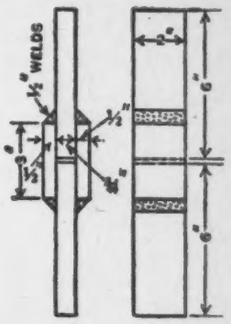
(34) Two gages, one covering 1/4-, 5/16-, 3/8-, and 1/2-inch fillets and the other covering 3/8-, 1/2-, 3/4- and 1-inch fillets, will meet most requirements in determining if the fillets are correct or imperfect, as at (35).

Various Imperfect Welds Compared with a Satisfactory Weld



(35) Weld of correct shape at *A* and seven examples of imperfect welds.

Test Specimen for Welds



(36) See (37)

(37) Test specimen for welds, as shown at (36), consists of four pieces of hot-rolled steel, welded with two layers, using 5/32-inch welding wire. This weld must meet the minimum test load of 40,000 pounds per square inch, which is equivalent to a load of 56,000 pounds on the test specimen.

*Based on data in paper read before the American Society for Testing Materials by R. Kraus of the Westinghouse Electric & Mfg. Co.

MACHINERY'S Data Sheet No. 223, New Series, April, 1932

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SHOP DATA ON AMERICAN OR BRIGGS STANDARD PIPE THREADS

Nominal Diameter of Pipe, Inches	Threads per Inch	Diameter of Hole before Tapping,* Inches	Diameter of Reamed Hole, Large End, Inches	Outside Diameter of Thread, Inches		Root Diameter at End of Pipe, Inches	Length of Full Depth Thread on Pipe, Inches	Outside Diameter of Pipe, Inches	Inside Area of Pipe, Square Inches
				At Large End of Hole	At End of Pipe				
1/8	27	11/32	0.345	0.404	0.393	0.334	17/64	0.405	0.057
1/4	18	7/16	0.445	0.534	0.522	0.433	13/32	0.540	0.104
3/8	18	19/32	0.583	0.671	0.656	0.568	13/32	0.675	0.191
1/2	14	23/32	0.721	0.836	0.816	0.701	17/32	0.840	0.304
3/4	14	15/16	0.932	1.046	1.025	0.911	35/64	1.050	0.533
1	11 1/2	1 5/32	1.169	1.308	1.283	1.144	11/16	1.315	0.864
1 1/4	11 1/2	1 1/2	1.514	1.653	1.627	1.488	45/64	1.660	1.496
1 1/2	11 1/2	1 23/32	1.753	1.892	1.866	1.727	23/32	1.900	2.036
2	11 1/2	2 3/16	2.227	2.366	2.339	2.199	3/4	2.375	3.356
2 1/2	8	2 5/8	2.662	2.862	2.820	2.620	1 9/64	2.875	4.788
3	8	3 1/4	3.289	3.489	3.441	3.241	1 13/64	3.500	7.393
3 1/2	8	3 3/4	3.789	3.989	3.938	3.738	1 1/4	4.000	9.887
4	8	4 1/4	4.287	4.487	4.434	4.234	1 19/64	4.500	12.730
4 1/2	8	4 3/4	4.786	4.986	4.931	4.731	1 11/32	5.000	15.947
5	8	5 5/16	5.349	5.549	5.491	5.291	1 13/32	5.563	20.006
6	8	6 3/8	6.406	6.606	6.546	6.346	1 33/64	6.625	28.890
7	8	7 3/8	7.402	7.602	7.540	7.340	1 39/64	7.625	38.738
8	8	8 3/8	8.400	8.600	8.534	8.334	1 23/32	8.625	50.027
9	8	9 3/8	9.398	9.598	9.527	9.327	1 13/16	9.625	62.786
10	8	10 15/32	10.521	10.721	10.645	10.445	1 59/64	10.750	78.854
11	8	11 15/32	11.519	11.719	11.639	11.439	2 1/32	11.750	95.033
12	8	12 15/32	12.518	12.718	12.633	12.433	2 1/8	12.750	113.097

Taper of standard pipe thread is 3/4 inch per foot; angle of thread, 60 degrees; depth of thread, 0.8 × pitch. The flats are formed by removing the sharp crest and root, each to a depth of 0.033 × pitch.

When a lathe tool is used for threading, it should be set at right angles to the center line of the pipe thread.

*To secure the best results, the hole should be reamed before tapping, with a reamer having a taper of 3/4 inch per foot.

MACHINERY'S Data Sheet No. 224, New Series, April, 1932

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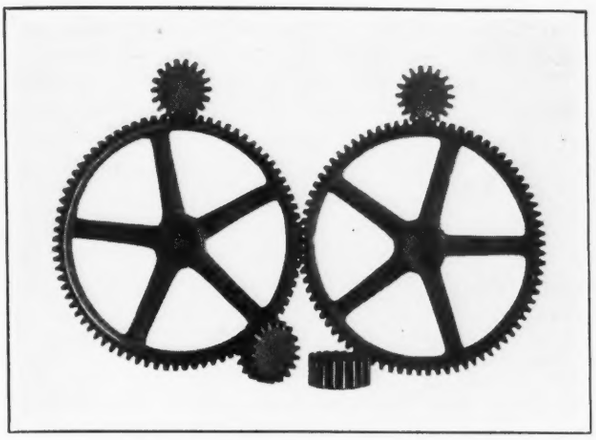


Fig. 1. Cast-steel Gears, the Teeth of which are not Machined

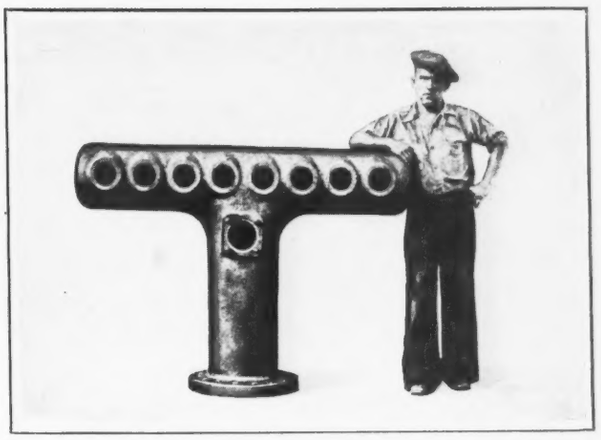


Fig. 2. Header of Cast Steel that Works at High Pressure and Temperature

Steel Casting Progress Makes for Dependability

Recent Improvements Made in the Methods of Producing Steel Castings Have Greatly Increased their Strength and Reliability

By F. WALTER BLACKEBY
Dodge Steel Co., Philadelphia, Pa.

MANY designing engineers hold the erroneous opinion that steel castings are not dependable. Their opinion is based on past experience, without taking into account the remarkable progress that has been made during the last few years.

Twenty-five years ago (and even ten years ago) steel castings were considered a necessary evil. They were used only when other materials could not be adapted to the purpose for which they were employed. Engineers and designers expected, when they used steel castings, to encounter numerous difficulties, such as surface sand, scale, and sand inclusions in the steel that would cause trouble in machining. Blow-holes and shrinkage cavities were prevalent, and in many cases the part had to be rejected after being partly machined, causing loss of money and much delay in the completion of the job.

Today, a marked improvement in the quality of steel castings has been effected as the result of research work, such as is being done by the Steel Castings Development Bureau, the Electric Steel Founders' Research Group, and other organizations, as well as by independent foundries. A study of sand conditions has largely eliminated the difficulty in machining caused by surface sand and sand inclusions, and avoided pinholes in and near the surface of the castings.

To prevent the formation of cavities on the inside of heavy sections (shrinkage cavities) an intensive study was made of methods of heading and gating. As a result, steel castings are now being produced that are solid throughout and very dependable. Co-operation between the designing engineer and the foundry engineer is also responsible for improvements along these lines. In the past, the engineer designed the part, and then sent the drawing to a patternmaker and the pattern to the steel foundry, after which he hoped to get a good steel casting.

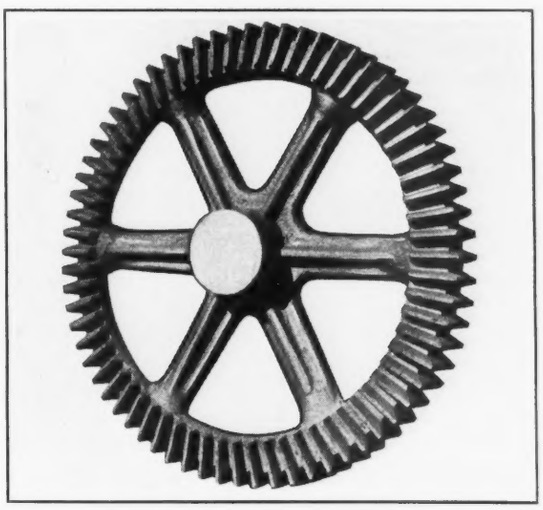


Fig. 3. A Cast-steel Bevel Gear with Cast Teeth, not Subsequently Machined

Today, most of the designing engineers are in touch with the foundry engineer and consult with him on questions of design from the foundry standpoint. This enables the steel foundry to make a satisfactory steel casting at minimum cost. The purchaser of steel castings today usually allows the foundry to make the pat-

tern equipment or else requests advice from the foundry as to how the pattern should be made to obtain the best results.

Improvements in molding machines and the extensive use of this kind of equipment have been large factors in the production of uniformly dependable steel castings. Any part that is reasonably standardized or that is required in fairly large

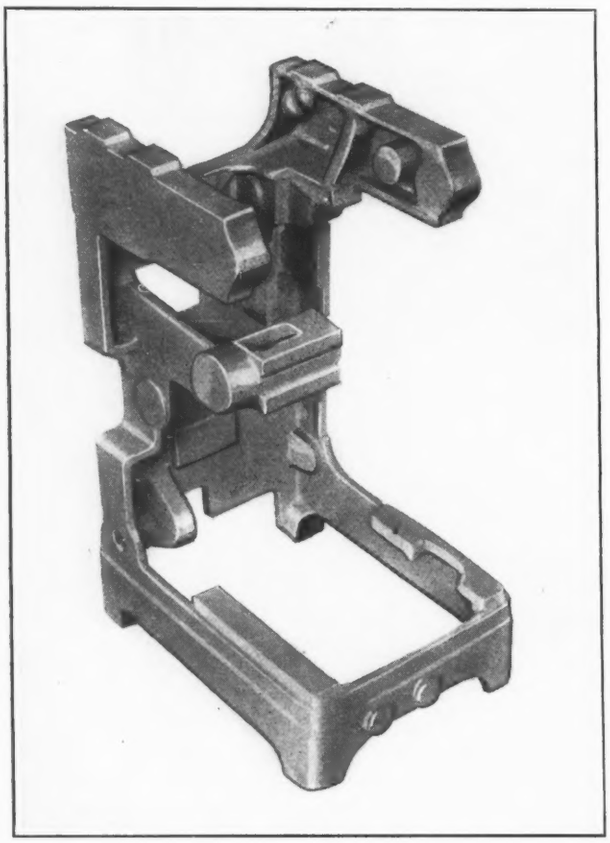


Fig. 4. An Intricate Frame for Electrical Equipment Made from a Steel Casting

quantities can be made on a molding machine, provided the pattern is suitably constructed. In some cases, the cost of pattern equipment suitable for machine molding is no greater than that of a pattern for hand molding.

It is customary in most foundries to make a sample casting on production jobs. After the sample has been approved, the arrangement of gates and risers, or heads, becomes a permanent part of the pattern equipment and is used whenever castings are made from that particular pattern. This eliminates the human element in the foundry to a large extent, and castings from the same pattern are made in the same manner, regardless of how much time has elapsed between orders.

The use of molding machines has also resulted in the production of steel castings that are truer to pattern than those molded by hand, as the pattern is vibrated by an air vibrator instead of being rapped by hand. The cast-tooth gears in Figs. 1 and 3, for example, are required to fit without machining the teeth. Proper pattern equipment and machine molding makes it possible to do this.

Through cooperation with the foundry engineer, it is often possible to make a part as one homogeneous steel casting, which is more rigid and stronger than a part made up of several sections riveted, welded, or bolted together. Fig. 4 illustrates a frame for electrical equipment. It is about three feet high and a foot wide. By cooperating with the designing engineer, this part was developed into a homogeneous, single piece of steel having the required rigidity and strength, with provision for numerous shafts and other parts that must be kept in line. Fig. 5 shows a frame for a stump-puller that is subjected to great strains. A single steel casting was made, which does the work satisfactorily.

Steel castings are now in service in oil refineries working at pressures of 1000 pounds per square

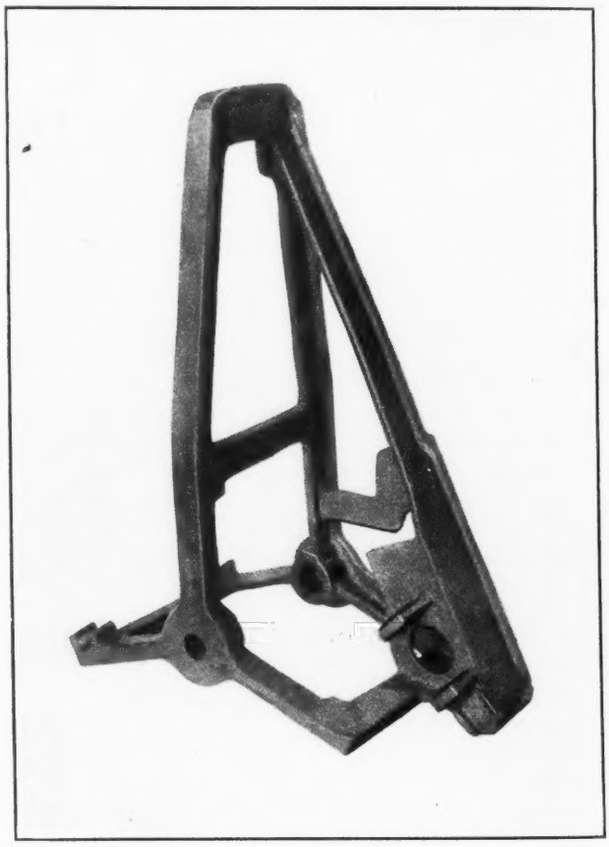


Fig. 5. Cast-steel Frame for a Stump-puller Subjected to Great Strains

inch and at temperatures of from 800 to 900 degrees F. Fig. 2 shows a header of cast steel which was placed in service where it was subjected to the high pressure and the high temperature encountered in oil refineries.

Properties of Carbon Steel Castings

The physical properties of carbon steel castings may be varied between the following figures, with carbon not over 0.35 per cent. This metal is readily machineable.

Tensile strength	70,000 to 87,000 pounds per square inch	
Yield point	40,000 to 55,000 pounds per square inch	
Elongation in 2 inches, per cent	25	20
Reduction of area, per cent	45	30
Brinell hardness	130 to 160	150 to 180

By the use of small additions of nickel, chromium, molybdenum, etc., and with special heat-treatment, it is possible to make steel castings having physical properties up to the following figures:

Tensile strength....200,000 pounds per square inch
Yield point.....150,000 pounds per square inch
Brinell hardness...300 to 500

Such results were not expected from steel castings even five years ago. The figures show the great strides that have been made in this field of engineering endeavor.

Adapting Non-Ferrous Metals to New Uses

Heat-Treatment and Age-Hardening of Non-Ferrous Metals and Alloys Have Opened up Many New Avenues of Usefulness

"MANY metals and alloys hitherto mechanically inferior to steel may now be brought up to the standard of steel, as far as mechanical properties are concerned, through the development within the past decade of a process known as age-hardening," Dr. Paul D. Merica, vice-president of the International Nickel Co., said, in the annual lecture of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers. "As a result," Dr. Merica continued, "the sphere of usefulness of the non-ferrous metals will be widened. Until comparatively recently, steel has been practically the only metal that could be hardened and strengthened by heat-treatment. It is for this reason, as well as because of its cheapness, that it has become such an indispensable material of construction.

"The non-ferrous metals—copper, lead, zinc, nickel, aluminum, tin—which are in many respects superior to steel, because of their corrosion resistance and electrical properties, have had limited usefulness in the past because of their mechanical inferiority to steel and because it has not been possible to improve their mechanical properties by heat-treatment. During the last ten years, however, the metallurgist's power to apply heat-treatments usefully in the hardening of non-ferrous metals has been substantially broadened through his understanding of the basic principles of 'age' or 'precipitation' hardening. All the common metals may now be alloyed in such a manner as to render them susceptible to age-hardening. Copper, for example, may be hardened to about 400 Brinell, a value comparable with that of spring steel. Copper-nickel alloys may be heat-treated to show tensile strengths in the neighborhood of 175,000 pounds per square inch, which is also comparable with the strength of heat-treated steel."

Explaining the process of age-hardening, Dr. Merica said: "After certain heat-treatments, these age-hardening alloys harden as they grow older. Sometimes they age, or age-harden, at room temperatures; sometimes they must be aged at higher temperatures. A single day is often adequate to bring about the desired changes in mechanical properties, although slight changes may continue for a month.

"What happens is that there is generated or precipitated throughout the metal or alloy a host of extremely fine, sub-microscopic particles of a hardening constituent. These very fine particles are uniformly distributed throughout the matrix of the metal and harden it.

"The significance of this development in the metal field is that it is now potentially within our power to harden practically any metal or alloy, and thus to put these formerly soft and weak metals and alloys on a comparable footing with steel as regards mechanical properties. The next decade will undoubtedly witness a substantial realization of our promise in this respect."

* * *

A New Use for Hard-Facing

An interesting application of hard-facing with Stellite is referred to in a recent number of *Oxy-Acetylene Tips*. The life of tire chains, particularly on trucks, is comparatively short; and when continuous operation is required, it is necessary to replace the cross-links, if not to purchase entirely new chains, several times during the season. By hard-surfacing tire chains, most satisfactory results have been obtained. In one case, the cross-links in untreated chain, after 120 miles of service, were so badly worn that it was necessary to replace them throughout. When the links were hard-surfaced after they had already been partly worn, the total mileage obtained from the original links was over 400 miles. The hard-facing operation costs less than replacing the worn cross-links.

Drawing and Bulging Horn-Shaped Shells from Flat Sheets

By F. C. DUSTON

IT seems impossible that the horn-shaped part of shining brass shown in the heading illustration could have been evolved from a flat disk. Yet such is the case. To the uninitiated the problem of designing tools and equipment for working a flat brass disk into a shell shaped like the horn of a Texas steer would seem to present considerable difficulty. Nevertheless, this work is accomplished with surprising ease and speed by the use of tool equipment developed by the U. S. Tool Company, Inc., Ampere, N. J.

The results of the successive operations performed in producing this part are shown in Fig. 1, while the nature of each operation is indicated in the accompanying table. The first operation consists of blanking and drawing the cup-shaped shell shown at *A*, Fig. 1. This shell has an outside diameter of 3 3/4 inches and a radius at the bottom of 29/32 inch. Strip stock 7 inches wide is employed for blanking out the work, the diameter of the blank being 6 15/16 inches.

Sequence of Operations Performed in Producing the Horn-Shaped Brass Shell

Operation Number	Kind of Work Performed on Shell	Outside Diameter of Drawn Shell, Inches	Radius at End of Drawn Shell, Inch	Thickness of Drawn Shell, Inch
1	Blank and draw	3 3/4	29/32	.....
2	Anneal	.....	.....	.....
3	Draw	3 1/4	3/4	.....
4	Anneal	.....	.....	.....
5	Draw	2.707	11/16	0.0480
6	Anneal	.....	.....	.....
7	Draw	2.131	5/8	0.0465
8	Anneal	.....	.....	.....
9	Draw	1.619	1/2	0.0460
10	Anneal	.....	.....	.....
11	Draw	1.320	7/16	0.0455
12	Anneal	.....	.....	.....
13	Draw	1.027	5/16	0.0450
14	Anneal	.....	.....	.....
15	Draw	0.922	5/16	0.0450
16	Cut off*	.....	.....	.....
17	Anneal	.....	.....	.....
18	Bend in die	.....	.....	.....
19	Anneal	.....	.....	.....
20	Expand in die	.....	.....	.....
21	Anneal	.....	.....	.....
22	Expand in die	.....	.....	.....

*Open end cut off and burred, leaving shell 12 11/16 inches long, ready for localized annealing preparatory to bending in hydraulic die.

The shell shown at *A* is annealed by heating it to a cherry red in an open gas furnace and quenching, before subjecting it to the succeeding drawing operation. Ordinary ring-type dies are employed for the deep drawing operations, which bring the shell to the proportions shown at *E* in the fifteenth operation. After each drawing operation, the work is annealed, as noted in the accompanying table. Following the fifteenth operation, the shell is cut off to a length of 12 11/16 inches.

After removing the burrs from the open or cut-off end of the shell, it is placed in the hydraulic forming or bending die shown in Fig. 2. This illustration is of a diagrammatic nature, such details as the clamps that hold the two die members together and the means for holding the aligning collar having been omitted.

The two parts of the die, *A* and *B*, are notched out at *C* to fit a locating post on the bed of the long-stroke, rack-type press on which the bending operation is performed. After clamping the two members *A* and *B* of the die securely together, and clamping the collar *D* in position, the

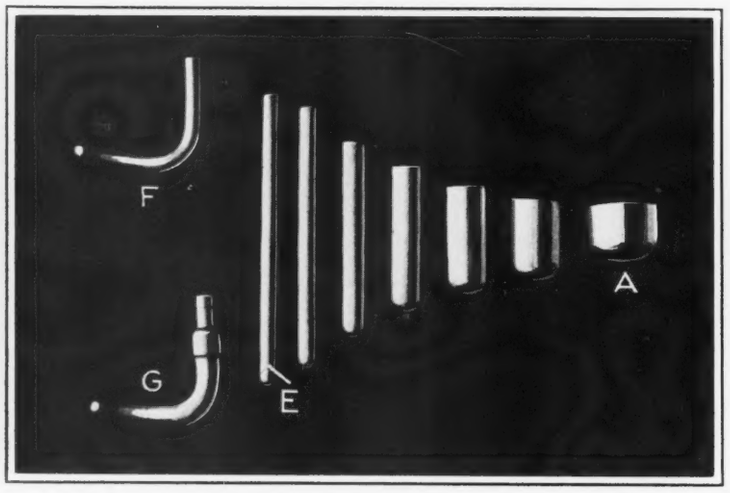


Fig. 1. Successive Operations Performed in Producing a Horn-shaped Brass Shell

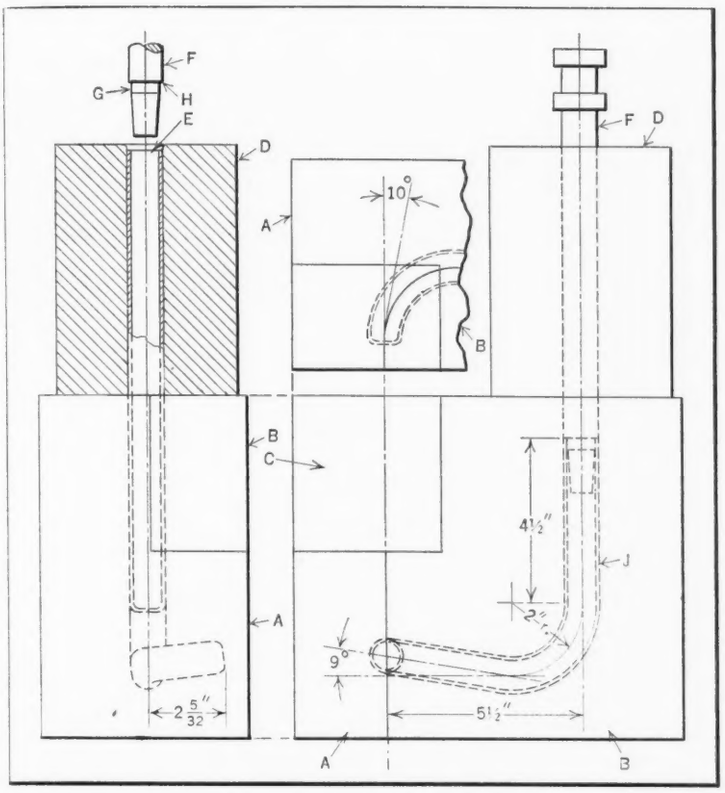


Fig. 2. Hydraulic Bending Die Employed to Bend Shell E, Fig. 1, to Shape Shown at F

drawn tube *E* is dropped into the position shown in the view to the left, with the lower end reaching to the point where the first bend in the die cavity begins.

The inside of the tube is next filled with an oil and water emulsion. The ram of the press then descends, causing the punch *F* to compress the water within the shell. This is accomplished by having the section *G* of punch *F* about 0.005 inch larger than the inside diameter of the shell. Continued downward movement brings the shoulder *H* into contact with the cut-off end of the shell. The punch then forces the shell into the die, causing it to bend or follow the curved cavity until the end of the shell reaches the end of the cavity. The shell is now in the position indicated at *J* in the view to the right. The punch is then withdrawn, the collar removed, and the die members *A* and *B* opened to permit the formed shell to be taken out.

After being annealed, the shell is placed in a hydraulic bulging die similar to that shown in Fig. 3. This die is the bulging or expanding die employed for the final forming operation on the shell. The die used for the preceding or intermediate bulging operation has a slight shoulder at *K* only. After the formed shell has been removed from the die shown in Fig. 2, it is placed in the cavity of the intermediate expanding or bulging die and filled with an oil and water emulsion. A punch held in the press ram then descends into the open end of the shell, compressing the liquid, which, in turn, forces the metal shell to expand and fill the die cavity. The punch used for this expanding operation is, of course, a tight fit for the inside of the open end of the shell.

The next, or final, expanding operation is performed in the same way by the die shown in Fig. 3. The annular groove at *L* is provided to receive a hardened steel ring which is a close fit over the outside of the shell. The two members *A* and *B* of the die shown in Fig. 3 are clamped together in the same manner as those shown in Fig. 2. One of the secrets of success in forming work of this kind is to anneal the shell properly after each forming operation. In the case of the bending or forming operations, local annealing at the points where the bends are made is employed, as required. This leaves the straight portion hard and able to withstand the pressure required in forming the bent portions. It might be mentioned that the small end of the shell is not required to be closed, and is cut off after the shell is formed.

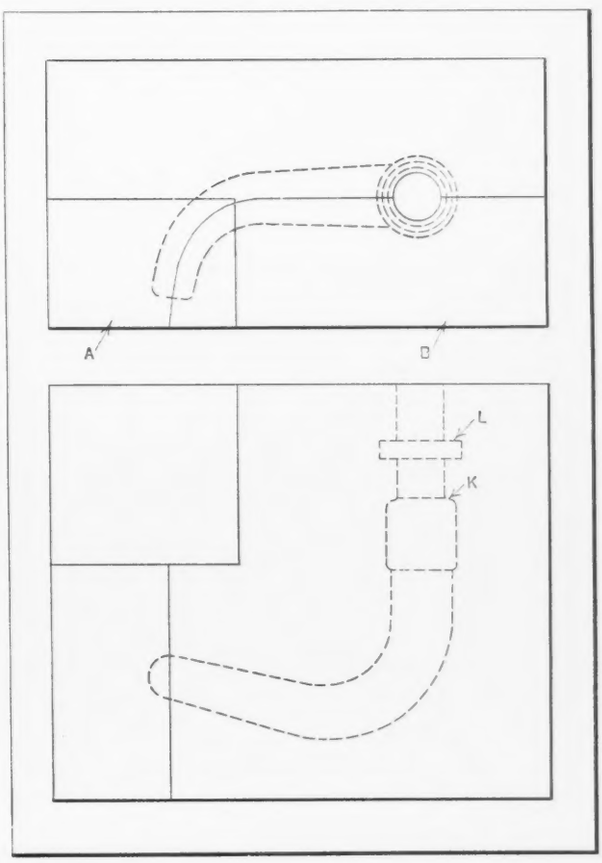
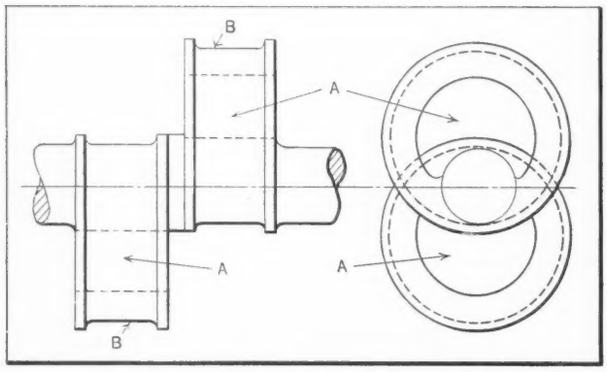


Fig. 3. Die Employed to Bulge the Bent Shell F, Fig. 1, to the Shape Illustrated at G

Ideas for the Shop and Drafting-Room

Time- and Labor-Saving Devices and Methods that Have been Found Useful by Men Engaged in Machine Design and Shop Work



Cast-steel Shaft with Cams Cored Out to Eliminate Blow-holes

Coring Cam Castings to Eliminate Blow-Holes

Coring out the sections *A* of the cast-steel duplex pump shaft shown in the accompanying illustration, instead of making the casting solid, served to give more solid or dense bearing surfaces at *B*. The use of cores in this manner resulted in more uniform castings and eliminated blow-holes, which had previously caused considerable trouble.

Detroit, Mich. G. N. DORR

Lathe Fixture for Dynamically Balancing Blower Wings

The dynamic balancing of blower wings like the one shown at *W* in the accompanying illustration is an important operation in the manufacture of Root blower-type superchargers for internal combustion engines. These superchargers operate at speeds ranging from 2000 to 5000 revolutions per minute, and any unbalanced condition in the wings causes undue vibration and excessive wear in the bearings. The wings are fitted with only a few thousandths inch clearance, and undue wear must be avoided, as it introduces the possibility of interference between the wings. The extremely simple and effective method described here for dynamically balancing the blower wings was devised by a concern manufacturing these superchargers.

The fixture used consists of a piece of machine steel, chucked in an engine lathe, and turned and bored as shown at *A* in the illustration. This fixture is used with the machine on which it was made. The blower wing to be balanced is screwed into the tapped hole *B*, and the lathe is operated at a speed of about 500 revolutions per minute. The web *C*, because of its thin section, is slightly flexible. Therefore, if there is any unbalanced condition in the blower wing, the shaft end *D* will "run out."

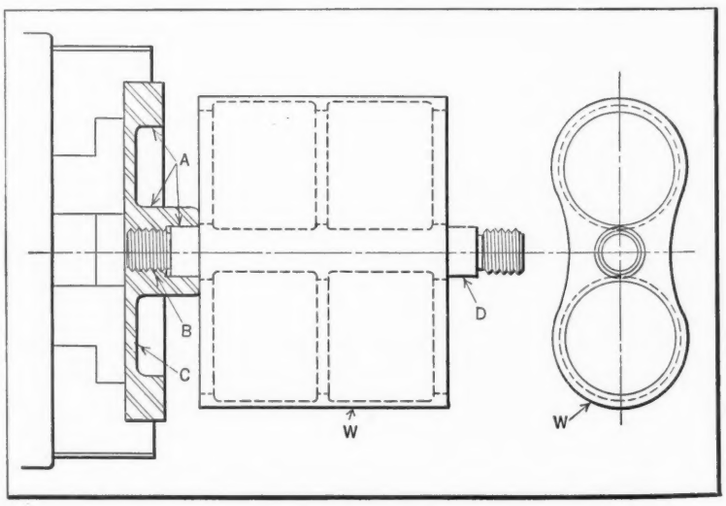
The high side is marked and a small amount of solder deposited on the inside of the light side of the blower wing. This is accomplished by the aid of an acetylene torch without removing the wing from the fixture. This balancing operation is repeated until the blower wing runs true, indicating that the outer end is in balance. The other end of the wing is then treated in the same manner. The blower wings are later checked with a static balance test. The effectiveness of this method of balancing has been proved by the satisfactory performance of the parts in actual service.

Indianapolis, Ind. GEORGE L. PYRITZ

Reducing Tool Costs with a Boring-Bar Cross-Index

Low cost in tool construction does not depend only upon economical design. As an example, boring-bars are often duplicated because no means are available for recording the fact that similar bars are already on hand. One shop has met this situation by installing a simple card index file.

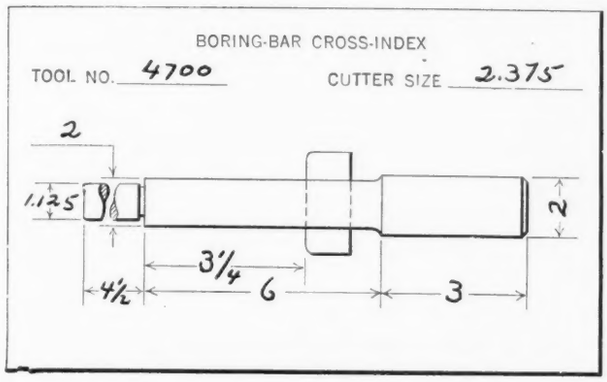
As shown in the illustration, on the printed form is the outline of a plain boring-bar body of the pilot type. When a boring-bar is designed, it is part of the draftsman's duties to sketch the cutter on this card, and also to fill in the general dimensions of



Fixture with Flexible Web at C for Use in Dynamically Balancing the Blower Wing W

the bar. The tool number and cutter size are filled in at the top of the card, which is filed in numerical order according to the cutter size.

If more than one cutter is shown on the card, only one card like the one illustrated is used, the size of one of the cutters designating its position in the file. Blank cards are used for each of the



Card for Recording the Design of Boring-bars so as to Prevent their Duplication

remaining cutters, the size being written at the top of each of these cards and reference being made to the original card for the other information.

Obviously, if this index is referred to before issuing an order for new bars, there will be little chance of duplication. This type of card has also been used for recording the designs of special reamers, drills, counterbores, etc.

Belleville, N. J. J. E. FENNO

Using an Indicator for Milling to Exact Depths

In drilling or counterboring quantities of pieces to a given depth on a milling machine, it is tiresome and rather difficult to gage the depth by the graduated dials of the machine. A better method is to use an indicator fastened to a strip of metal which is clamped to the table of the milling machine, as shown in the accompanying illustration. The work end of the indicator is brought into contact with the vertical bearing of the machine frame, and is set to read zero when the piece has been drilled, reamed, or counterbored to the correct depth. On succeeding cuts, the operator simply watches the indicator and stops feeding when it registers zero.

WILLIAM C. BETZ
New Britain, Conn.

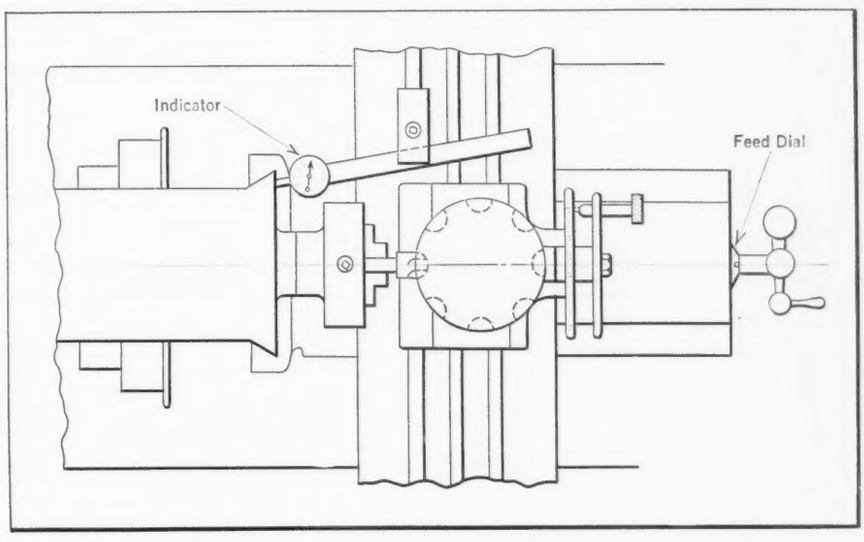
Bunting Brass & Bronze Co. Celebrates Twenty-Fifth Anniversary

The Bunting Brass & Bronze Co., Toledo, Ohio, was founded just twenty-five years ago by William Bunting, who was born in Ireland and who began his career in the bronze industry at the age of twelve. At that time he was apprenticed to serve seven years at brass founding, receiving a wage of 1/6 (36 cents) a week for a twelve-hour day. When he was twenty years old, he was made foreman of the foundry. In 1880, he came to America, and after having been employed for many years by well-known American brass and bronze plants, he established the Bunting Brass & Bronze Co. in Toledo in 1907.

The company now has branch offices and warehouses in nine industrial centers, in addition to a most modern plant at Toledo. During the last twenty-five years, the vast amount of research and experimentation made by the company has added materially to the knowledge of the properties of bronze alloys and their uses. This research work has been carried on both in the company's own laboratories and in collaboration with the United States Bureau of Standards.

* * *

Let us look at the background against which American business today is projecting its efforts to succeed at home and abroad. Let us review our national assets. Here are a few of our social assets: A stubborn and transcendent belief in ourselves and in our future; confidence in the tradition, born of 150 years of history, that America can meet and conquer any crisis; determination to give our children a better place to live in and more of comfort and enjoyment; a tremendous fund of American ingenuity, adaptability, alertness, and courage with which to meet our problems.—*Frederick M. Feiker*, Director, Bureau Foreign and Domestic Commerce



Method of Mounting Indicator in Convenient Position for Gaging Depth of Drilled or Counterbored Holes

The Increasing Cost of Selling Tools

While Production Costs are Steadily Being Reduced, Selling Costs Show a Tendency to Increase—Why?

By C. B. COLE, President
Tool Equipment Sales Co., Chicago, Ill.

THE cost of selling small tools is constantly increasing, not only because of unwise competition, but also because of other factors. One of the causes of this condition is that there are too many concerns manufacturing small tools, relative to the potential customers. This is partly explained by the fact that the quality of tools has been vastly improved, enabling the user to obtain larger production with the same tools. Cutting tools made from greatly improved materials are an outstanding example of this.

Another cause of over-production of small tools is the desire on the part of some of the employes of tool-manufacturing concerns, jobbing shops, and other plants, to go into business for themselves. The usual idea back of a move of this kind is the thought that some tools can be manufactured at a considerable profit. An ambitious man begins to figure how much money he could make if he were able to manufacture these tools in a shop of his own.

Sometimes employes suggest to the management that if certain types of machines were purchased, more production could be obtained at a great saving. When suggestions of this kind are ignored by the management, the employe feels that if he were able to go into business for himself, he could effect these savings and make considerable money. He raises what money he can, and in due time a new tool shop is started in some garage or loft building. This creates competition for the parent organization and the other manufacturers of tools, increasing the over-production by the capacity of the new shop.

After starting in business, the new tool manufacturer finds that, to obtain orders for tools, he has to quote lower prices than his old employer did, and this he generally does, assuming that because he has newer equipment or better methods, he can afford to ask lower prices for his tools and still make the same margin of profit that the old concern makes.

He forgets, in many instances, that there are certain definite fixed charges and overhead that must be taken into consideration, and before he learns this, considerable damage is done to other manufacturers in the same field. While it is true that the percentage of new concerns that fail in a comparatively short time is very large, there are always some that survive long enough to cause considerable disturbance to the trade in general.

The Engineering of Customers' Jobs is a Costly Procedure

The engineering work that is done free of charge for prospective customers is another factor that tends to increase the cost of selling small tools. It is the practice of a great many shop executives to call in a tool salesman who is known to have some mechanical ability and ask him to help solve a problem that the customer is not capable of solving himself or does not want to take the time to work out. Often it is an impossible job, and the salesman can determine this without much loss of time. Frequently, however, the salesman is able to work out the problem, after spending several hours going over the details of the job and making suggestions that may or may not meet with the approval of the shop executive. The salesman makes notes and sketches, and then takes the matter up with his factory.

This information is gone over very carefully at the factory, and a lay-out and quotation are submitted to the customer. The salesman receives a copy of the data and quotation, but when he calls on the purchasing department to obtain an order, he is informed that the customer is waiting for prices from other concerns. It would not be quite so bad if all the competitors had been called in and asked to go over the job, the same as the original bidder was requested to; but it is common practice among some manufacturing concerns to get information in this way, and after having obtained it, request prices from competitors who have had no sales or engineering expense on the job. Then, because a cheaper price is quoted, the order is placed with the competitor. This practice increases the sales cost of the concern that employs a salesman with real mechanical ability. There is no compensation for such work unless the order is obtained.

Special Engineering Work and Tool Design Should be Paid for by Customer

Still another factor that increases the sales cost of small tools is the practice followed by many concerns of requesting quotations for a quantity of special tools from many—perhaps six or more—tool manufacturers. If these tools were of standard design, it would not mean much expense to submit a quotation; but when they are special, it requires, in many instances, a great deal of engineering and correspondence. In the majority of cases, only one concern gets the order.

This practice results in a great loss for the concerns who are making quotations. It would seem only fair to expect a consumer who requests prices for special tools, involving considerable expense on the part of the tool manufacturer, to pay for the cost of the special design work in the event the order is not placed with the concern quoting. This would give the tool manufacturer a return on his investment in engineering ability.

If a charge were made for the cost of submitting a quotation that involves engineering service, it is safe to say that the number of inquiries that would be sent out would be reduced materially. A charge of this kind would also eliminate inquiries for the purpose of finding out how much a new product should cost, without the expense of estimating it in one's own plant. Reducing the number of unnecessary quotations would result in a great saving to the tool manufacturer and to the customer as well. Somebody has to pay this expense.

The ultimate result would be that the customer would either employ competent engineers and tool designers for his tooling problems or engage the services of a responsible consulting engineer. It is true that competition is the life of trade, but unintelligent competition does nobody any good.

Reducing Selling Expense by Cooperative Selling

There is another direction in which the selling cost of small tools might be reduced. In practically every large industrial center, the larger tool manufacturers maintain their own individual branch offices. This means rent of a store or office, salaries of managers, clerical help, etc. In normal times, the expense of maintaining an organization of this kind is absorbed by the large volume of business done; but in times such as we are passing through, this expense becomes a serious item. One way of overcoming this would be to employ a manufacturer's representative on a straight commission basis.

Another would be for several manufacturers of non-competitive tools to maintain a joint sales office. The latter method might not work out satisfactorily, because each individual manufacturer might feel that the other lines handled were getting more attention than his; but this plan would mean the elimination of duplicate branch offices and managers and of a considerable number of tool salesmen. The combined group could afford to employ the services of tool salesmen and sales engineers with real mechanical and sales ability. This would also prove to be a more attractive proposition to the customer. By having only one salesman calling on him instead of several, he could purchase his requirements with the least waste of time. Economies must be effected to reduce high selling costs, and the foregoing suggestion might be one of the solutions of the problem.

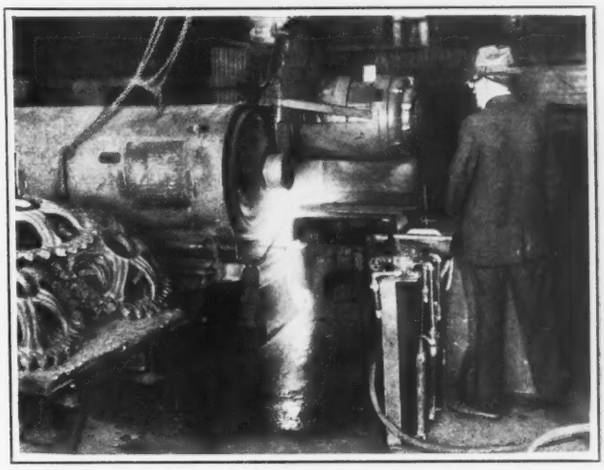
* * *

Summer Course in Management

For seventeen years, the Pennsylvania State College has been offering a summer management course for industrial executives with the view of presenting to foremen and others some of the newer principles of industrial management. This year, the course will be held June 8 to 16. Further information may be obtained by addressing C. E. Bullinger, Department of Industrial Engineering, Pennsylvania State College, State College, Pa.

Saving Costs by Using a Friction Saw

An interesting example of speeded-up production and reduced manufacturing costs was recently noted at the Harrison Steel Castings Co.'s plant at Attica, Ind. In this case, a high-speed friction saw, manufactured by the Kling Brothers Engineering Works, Chicago, Ill., is used for removing risers from cast-steel sprocket wheels and pulleys. A fixture is used for rotating the sprocket wheels and pulleys while the risers are being cut off, as shown in the accompanying illustration. The sprockets are rotated while the saw advances to make the cuts. In this way, the saw blade makes a minimum contact with the work, requiring a minimum amount of power for each cut. The actual cutting time for a hub riser is less than fifteen seconds, the floor-to-floor time being about thirty seconds.



Cutting off Risers from Cast-steel Sprockets by Means of a Friction Saw

* * *

National Metal Trades Association to Meet in New York

The thirty-fourth annual convention of the National Metal Trades Association will be held on April 20 at the Hotel Commodore in New York. Many subjects of current importance to industry will be discussed, including unemployment insurance, the necessity for drastic reductions in national and local government expenses, and the status of credit. The Association's Committee on Industrial Relations has just completed its analysis and report on unemployment insurance. This subject has created the keenest interest among manufacturers. At the convention, the election of officers will also take place. Jacob D. Cox, Jr., president of the Cleveland Twist Drill Co., has been nominated for the presidency to succeed J. G. Benedict, general manager of the Landis Machine Co., Waynesboro, Pa., who has served as president for two years.

In conjunction with the convention, a meeting of the branch secretaries will be held April 19.

Special Tools and Devices for Railway Shops

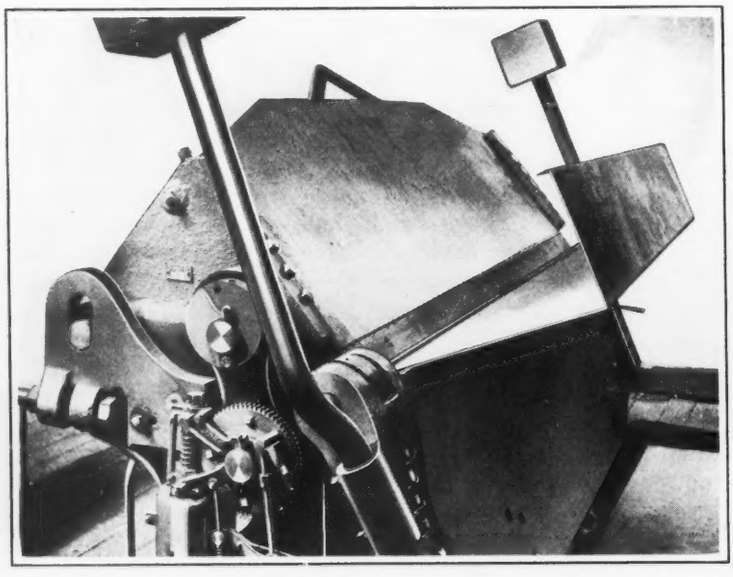
Recommended by Railway Shop Superintendents and Foremen

Bending Brake Saves Time on Sheet-Metal Work

By H. O. CHARLES

Locomotive ashpans, tender tanks, and other sheet-metal parts formerly made by riveting angle-irons to the ends of the sheets are now largely constructed of one piece in the Stratford, Ontario, shops of the Canadian National Railways. These important changes in the design of sheet-metal work were made possible through the use of the large press brake here illustrated. The brake has a maximum capacity for sheets up to 12 feet in length by 3/8 inch in thickness. Shorter and thinner sheets can, of course, be handled.

Bends of 90 degrees and slightly greater can be readily made by swinging up the bending beam at the front of the press. Through the use of blocks, sheets can be folded back a full 180 degrees. The bending beam is adjustable to suit the radius of the bend and the thickness of the sheet. This machine has proved a big time-saver in the sheet-metal shop.



Press Brake which has Made it Possible to Use Simplified Designs of Sheet-metal Parts for Locomotives and Tenders

Self-Centering Blocks for "Tramming" Side-Rods

By E. A. LOTZ, Foreman, Pennsylvania Railroad Shops
Juniata, Pa.

In some railroad shops, the "tramming" of side-rods is accomplished by fitting a wooden bar tightly across the inside of the bore at each end of the side-rod. The centers of the bores are then marked on the bars and the center distance "trammed" or measured. This inspection is quite important and is frequently required.

A quicker method of tramming than the one described, however, is to use two self-centering blocks like the one shown in the illustration. The advantage of these blocks over the wooden bars is that, when applied to a bore, they immediately centralize themselves, so that the center distance can be easily checked by measuring the distance between the center holes in the blocks.

The construction of the blocks will be clear by referring to the illustration. *A* is a plate to which are secured three supporter fingers *B*. On the under side of the plate is the disk *C* which turns freely on the stud *D*, fastened to the plate. Three centralizing pins *E*, pivoted to disk *C*, are guided at their outer ends by the blocks *F*. These blocks are also pivoted to disk *C* and are free to oscillate according to the angular movement of the centralizing pins. Releasing knob *G* is fastened to the disk and passes through an elongated hole in plate *A*.

In use, knob *G* is swung toward the right. This rotates disk *C* and causes pins *E* to recede. The block is then located at the end of the bore (indicated at *J*) with the fingers *B* resting on the hub of the side-rod and the centralizing pins *E* in the bore. The knob *G* is now moved toward the left by the action of coil spring *H* until the three centralizing fingers are in contact with the bore. In this position, a small center hole in the

hardened plug *K* will be exactly central with the bore of the side-rod, this hole being the measuring point.

* * *

Results with Roller-Bearing Equipped Locomotive

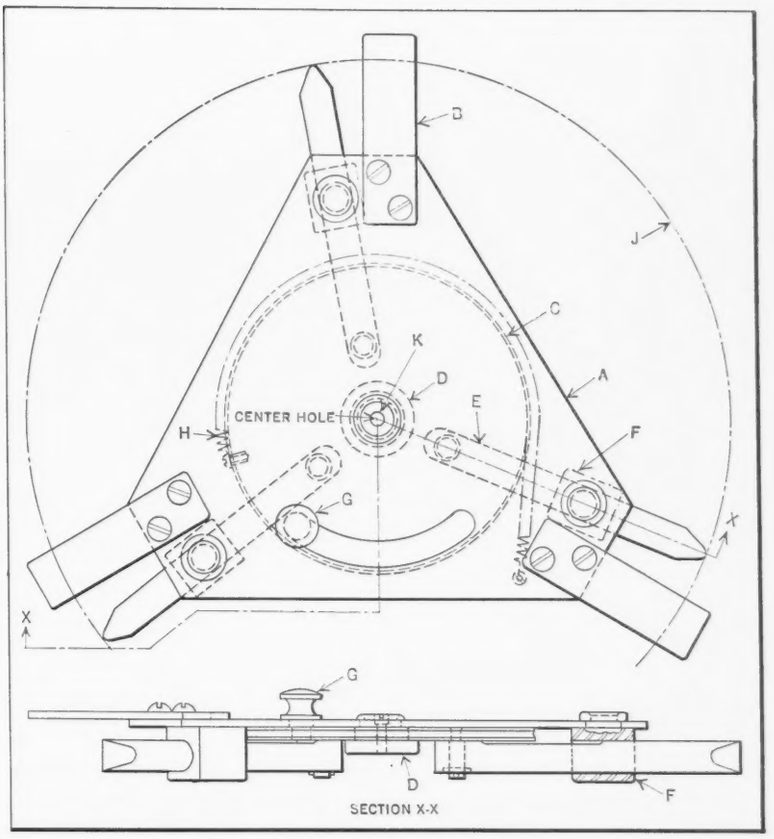
After operating on fourteen different railroads since it was put in service in April, 1930, the first locomotive ever to be equipped with antifriction bearings recently completed its first 100,000 miles. The locomotive is provided with Timken tapered roller bearings for all axles—engine truck, driver axles, trailer truck, and tender trucks.

During the test period, the locomotive has operated from Coast to Coast under every conceivable condition of climate, temperature, and trackage. It has hauled heavy freight trains and fast passenger trains. Throughout the entire test period not a single instance of bearing trouble has been recorded; no train delay was ever occasioned by bearing disability.

During the 100,000-mile period, a substantial saving has been made by not having to repair or replace the bearings; in addition, indirect savings have resulted from the protection to other parts, because of freedom from lateral motion and vibration. Lower maintenance costs were also recorded due to the fact that no attention had to be paid to lubrication for periods of several months at a time.

An increase in starting efficiency, as indicated by the tests, shows that the bearings increase the locomotive tractive power when starting trains. The locomotive was built to the specifications of the Timken Roller Bearing Co., Canton, Ohio, to demonstrate the value of roller bearings in locomotives. It had formerly been thought impossible to use antifriction bearings for this service.

The building of a large passenger locomotive for demonstration purposes is a remarkable example of the progressive attitude of the company that undertook this work.



Self-centering Device for Locating Center of Side-rod Bore

The Timken Roller-bearing Equipped Locomotive after Having Completed its First 100,000 Miles

The Shop Executive and His Problems

Superintendents and Foremen are Invited to Exchange Ideas on Problems of Shop Management and Employe Relations

I BELIEVE that the suggestion in January MACHINERY, page 336, relating to the marking of steel for identification would not be practicable. Definite rules for heat-treatment cannot be given, because the same steel may have to be heat-treated in a different manner according to the uses to which the tools are to be put. For example, a 1.10 per cent carbon steel, such as is used for many kinds of tools and dies, may, because of thin sections, have to be oil-quenched at 1460 degrees F., in order to avoid breakage. To obtain sufficient depth of hardness in other cases, the same steel may have to be water-quenched at 1435 degrees F.

Alloy tool-steel dies used for hot-forging may be heat-treated within quite a wide range of temperature, according to the uses to which the dies are to be put and their design. Experiments conducted by the writer have shown that no one treatment is correct for all dies, even though they are made from the same steel. He has also found that different quenching media are required for tools that are to be used for different purposes.

Hence, it would not be practicable for the steel manufacturer to give specific directions for heat-treatment. When the best results in production and life are expected from a tool, the only way is to determine upon the treatment by experiment, and see to it that the treatment suitable for the particular purpose in question is adhered to.

D. A. SHAW

Production Engineers Know the Value of New Equipment

The editorial in December MACHINERY on the subject of new shop equipment emphasizes the need of equipment that is in first-class condition, especially on mass-production work. The average production engineer is handicapped in many cases by lack of new equipment. In times of business depression, manufacturers must, in order to make sales, either design new products, improve old ones, or reduce prices and costs.

When costs have to be reduced without changes in the production lay-out, the production man is generally in trouble—especially if more exacting manufacturing limits are required. To produce work to closer limits and at the same time reduce the percentage of scrap is, in most cases, a difficult task; and if management would temporarily look more to the scrap heap and think less of dividends, it would soon have more funds for dividends. Millions of dollars are being wasted annually in scrap in the industries. Unless more attention is given to this phase of manufacturing losses, there is little prospect of a firm being able to lower costs continuously. The best way to reduce costs, and at the same time work to closer limits, is by the use of modern methods and equipment.

DOUGLAS T. HAMILTON

Selecting the New Supervisor

There is much difference of opinion as to the qualifications of a foreman or superintendent. Some say that a man with practical training only should be chosen, while others believe that a man with technical training is preferable. It seems rather obvious that if you can obtain a practical man with technical training, you have the best combination both for foreman and for superintendent.

In these days, no shop man has an excuse for not obtaining a technical training. We have evening schools, correspondence schools, and public libraries. Every shop man with ambition has a chance to obtain a fair technical education. A man who thinks that he should be promoted by reason of length of service alone should not even be considered. Any man who thinks that he can learn everything by experience is narrow-minded. If promoted, he is likely to retard progress.

The management should encourage home study among the men. It would be well to map out some course of study suitable for the man who is ambitious and eager for promotion. Employers who encourage their men to study subjects pertaining to their work and help them to select the proper school and books will find their efforts rewarded. Plant libraries with technical books and magazines are to be recommended.

If technical training is desirable in a foreman, it is even more so in a superintendent. He must be the bridge between the practical man in the plant and the engineering department. When the superintendent is wholly a "practical man," there is usually warfare between the shop and the engineering force. On the other hand, a technically trained superintendent with a broad shop practice can make the shop and the engineering department cooperate successfully.

WARREN F. MANTHEI

Every man must make his own job. It is not provided for him by somebody else.

Fan-Cooled Motors Promote Economy

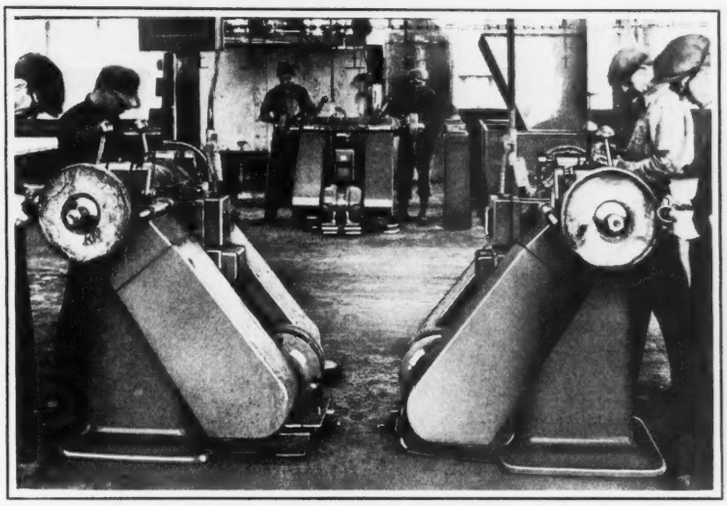
The Cooling Arrangement Permits the Use of a Motor No Larger in Size or Capacity than a Motor of the Open Type

By C. L. PETERSON, Application Engineer
Reliance Electric & Engineering Co.
Cleveland, Ohio

FULLY enclosed motors were developed years ago. They are sealed tightly and designed to exclude dirt, moisture, etc.; hence the windings are fully protected. But motors enclosed by merely adding covers to seal all openings have a serious disadvantage—the heat generated in the motors cannot escape readily. As a result, the horsepower output of open motors of similar sizes cannot be obtained. To fully enclose an open motor of average size without an adequate cooling arrangement reduces its horsepower rating about one-half. In the larger sizes, this reduction in output becomes even greater. This objection has been overcome by means of enclosed fan-cooled motors. They not only exclude foreign matter, but are so constructed that in most sizes they are no larger than open motors of the same capacity.

Some users of motors have questioned the reliability of enclosed fan-cooled motors. They fear that they will not stand up under adverse conditions and prefer the ordinary fully enclosed type, even though the cost is from one and one-half to nearly three times as much as an open motor of the same rating. Others feel that the old method of inspecting the motors frequently and blowing them out is more economical than paying the slight extra cost of enclosed fan-cooled motors. However, many manufacturers have tried enclosed fan-cooled motors and found that a considerable saving can be effected by their use.

In the automobile industry, for instance, a few of the latter type were carefully tried here and there, and now great numbers are being used on all kinds of machines. On a single application, where a three-horsepower, enclosed fan-cooled motor was exposed to cast-iron dust, $56 was saved in a year on motor maintenance. The difference in cost between the fan-cooled motor and the open motor was saved in seven months.



Grinders Driven by Fan-cooled Motors. Closed Construction of Motor Excludes all Emery and Steel Grindings from the Windings

Grinders have always presented a troublesome motor application problem. The combination of fine metallic dust and emery dust in installations such as that shown in the illustration is most harmful to motor windings. Maintenance men in many plants can point out motor applications where the windings must be rewound every month or two unless the enclosed type of motor is used. Enclosed fan-cooled motors are now driving all sorts of grinding machinery successfully, and are the solution of many grinder-motor difficulties.

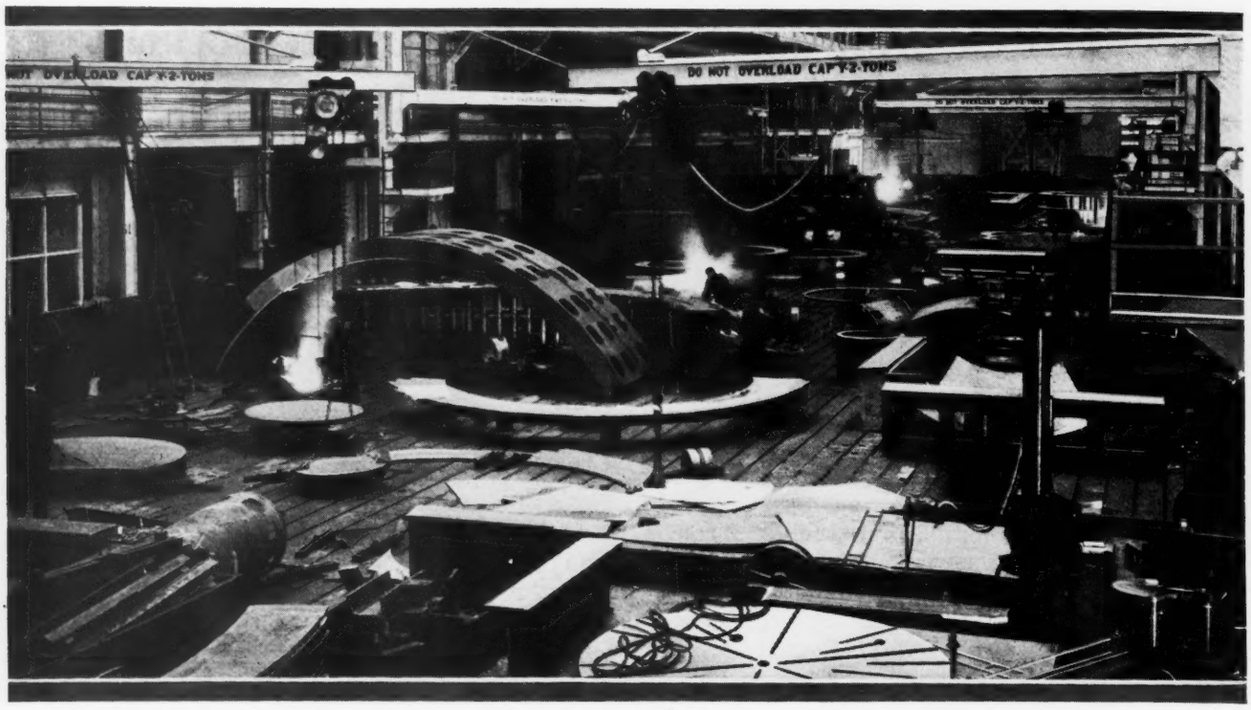
Enclosed fan-cooled motors are a real economy in the foundry. Foundry dust is extremely fine and penetrative. It does not take long for it to play havoc with motor windings. On one installation where a great amount of trouble was experienced with motors driving a rotary-table sand-blast, an enclosed fan-cooled motor was installed. This has given uninterrupted service since its installation over three years ago. The only attention it receives is periodic lubrication of the bearings.

The applications of fan-cooled motors referred to in the preceding paragraphs indicate the many types of installations for which these motors are adapted.

* * *

Shop Practice Meeting Planned

According to an announcement by R. E. W. Harrison of the Cincinnati Grinders, Inc., the Machine Shop Practice Division of the American Society of Mechanical Engineers, of which Mr. Harrison is chairman, is planning to hold several sessions during the week of the Machine Tool Exhibition in Cleveland, September 10 to 17. A program that will be of especial interest to shop executives and those concerned with the efficient operation of machine shop equipment is being planned.



Should it be Cast or Welded—or Should Both Methods be Combined?*

By J. G. RITTER, Welding and Foundry Engineer, Westinghouse Electric & Mfg. Co. East Pittsburgh, Pa.

WELDING can now be considered as important a process as riveting and casting for making metal products. Welded structures and structures formed by combinations of castings and welded steel are widely used by the Westinghouse company. Over 1000 tons of these structures are manufactured a month, in spite of the fact that the company operates five iron foundries and one steel foundry. In the heading illustration is shown an interior view of the welding shop in the Westinghouse plant, where most of the welded structures are made.

*Abstract of a paper presented at the annual meeting of the Steel Founders' Association in Chicago on January 21.

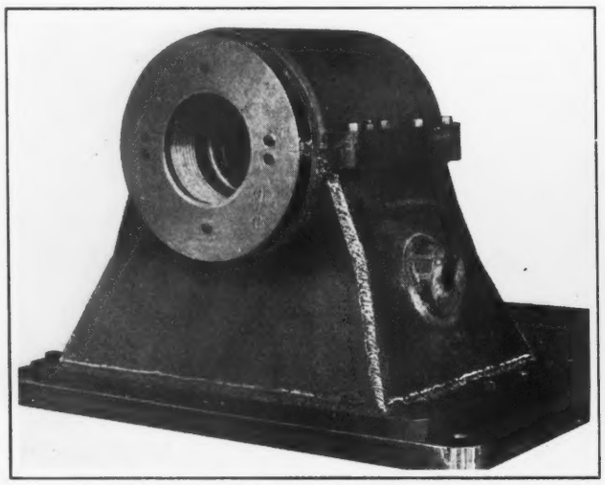


Fig. 1. Welded Bearing Pedestal which Could be Cast More Economically if More than Four Were Required

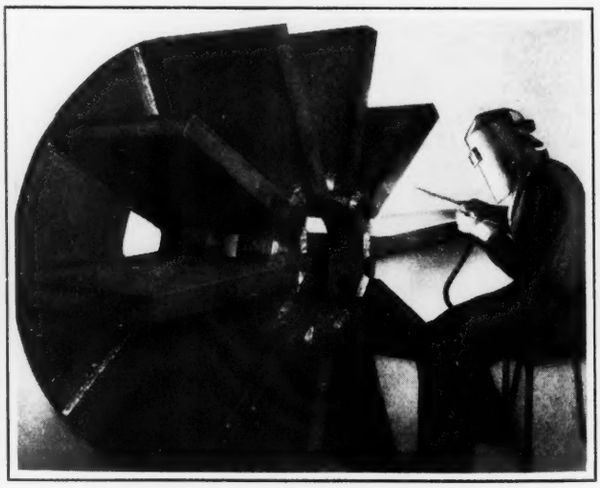


Fig. 2. Welded Construction is Found to be More Economical than Casting for this Direct-current Rotor

Past experience has established quite definitely the economical dividing lines between the different methods of construction. The relative costs of a riveted and a welded structure are quite easy to determine, being largely a comparison of the actual riveting operation cost and the welding operation cost.

A comparison between the costs of welded structures and castings becomes much more complicated, especially when the manufacturer operates a foundry. In general, the most important factor is the number of pieces to be made. For a few pieces, the saving in pattern cost usually insures low cost construction in welded steel. For example, the bearing pedestal shown in Fig. 1 is of welded construction, but can be more economically made by casting if more than four are needed. When the production is high, the pattern does not affect the cost comparison very much, because the pattern cost is usually about the same as the cost of the jigs and special tools required for welding.

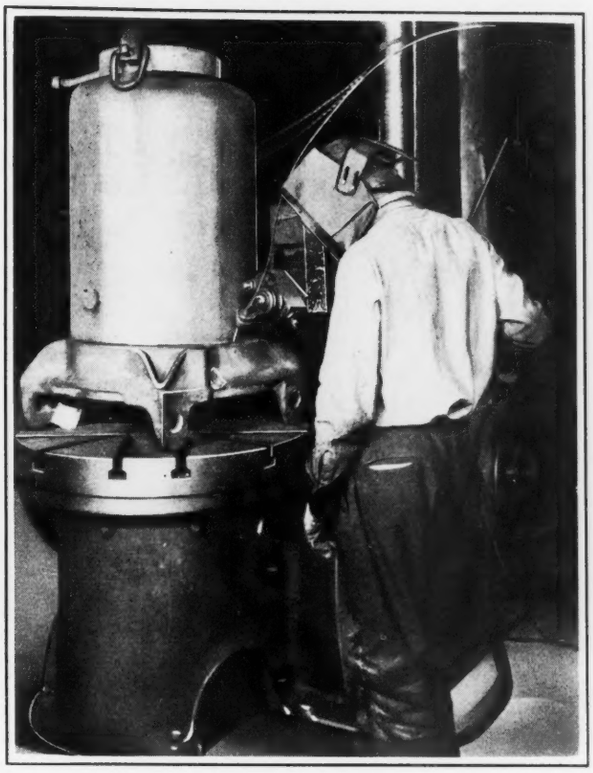


Fig. 3. Circuit-breaker Tank to which a Cast-steel Ring is Being Welded. The Tank is Rotated as the Weld is Deposited by an Automatic Welding Head

Synchronous motors are made in large numbers. The frame, rotor, and bedplate are of welded construction, and the bearing pedestal is of cast iron. Bedplates of welded construction are the most economical, regardless of the quantity involved, inasmuch as this type of structure has a small amount of welding and fitting, relative to the weight involved. They are constructed of standard rolled shapes, cut to length, and fitted with very little labor and waste.

The rotor shown in Fig. 2 is subjected to very high stresses, being used in reversing mill motors. Welded construction is most economical for this type of design, except on the smaller sizes, which are made of cast steel. There is a factor other than cost which is often involved in deciding upon which construction is to be used. That is the question of quick delivery. The welded construction has the advantage here.

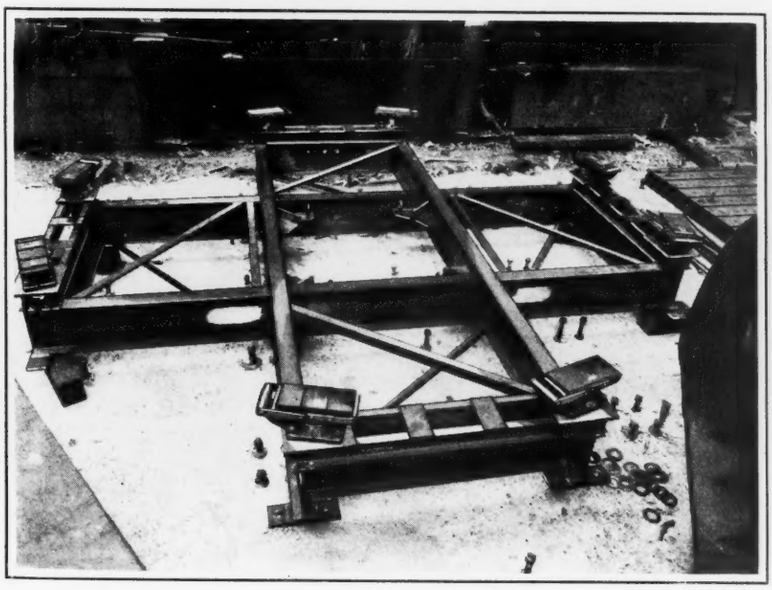


Fig. 4. Four Steel Castings are Welded to the Inside of This Large Structure for Supporting the Guide Bearing of a Large Water-wheel Generator

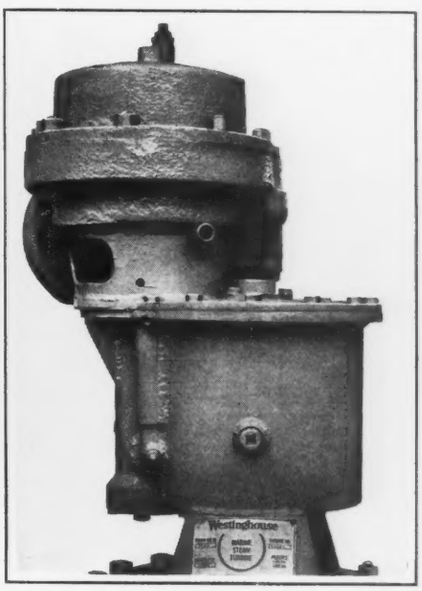


Fig. 5. Turbine Having Cored Passages which are Cast and then Welded in Place

Fig. 6. Gyroscope Frame, the Main Trunnion Supports of which are Steel Castings, Welded to the Main Structure

In general, the welded structure does not have so great an advantage when substituted for steel castings as it does when substituted for iron castings. This is due to the fact that cast steel is as strong as the rolled steel used in welded construction. In replacing an iron casting, the welded construction can be made much lighter and the welds do not have to be very large in order to give a structure comparable in strength. In steel, however, the casting design has to be followed almost exactly, and the welds have to be large enough to develop the full strength of the steel sections.

Very often the cost of a welded structure is increased materially, because some parts of it are quite complicated and require a relatively large amount of labor. The logical thing to do in such a case is to construct these parts of steel castings and then weld them in place. Cast steel with a carbon content of 0.30 per cent and under can be welded as successfully as rolled steel. Higher carbon and alloy steels can be used if the proper welding procedure is employed.

In Fig. 3 is shown a circuit-breaker tank with a cast-steel ring being welded to its top rim. Various pockets and brackets are combined in the casting. It is machined and drilled complete, and then welded to the tank. The tank is rotated by the turntable shown, and the weld deposited by the automatic welding head. This method of construction insured a good gasket fit for the tank top, as well as low manufacturing costs.

A combination of a large fabricated structure and steel castings is shown in Fig. 4. This apparatus carries the lower guide bearing of a large water-wheel generator. The guide bearing is supported by four steel castings, which are welded to the beams near the center of the structure.

In making welded steam turbines, there are several parts for which castings can be used to advantage. Some of the parts with cored passages are cast and then welded to the rest of the structure, as shown in Fig. 5.

The apparatus shown in Fig. 6 is the main frame of a gyroscope which is used to control the oscillations of a large ship. The main trunnion supports are steel castings, welded to the main fabricated structure.

An interesting combination of a welded structure and cast iron is that of a transformer tank used in underground work. Sheet metal is formed and welded to make the side walls, which are then put into molds, and the tops and bottoms cast in place.

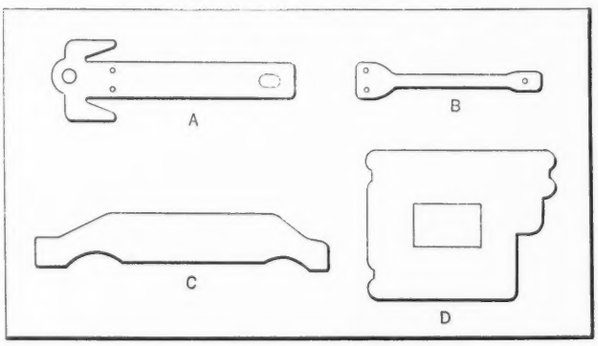
* * *

Stampings Produced Rapidly and Economically in Lots of 100

An important point to be considered in manufacturing stamped parts in small lots is the die cost. Unfortunately, many die rooms operate on a plan that ordinarily would not be permissible in a production department. As a result, the dies for a production as low as one hundred parts are expensive. Realizing this, a few concerns specializing in dies and stampings have found it profitable to specialize in small-lot production. For example, the Continental Machine Specialties, Inc., Minneapolis, Minn., makes practically any shape and size of stamping up to the capacity of a 100-ton press in lots of from 100 to 2000. The stampings may be made of various materials up to 3/8 inch thick. As a rule, the first 100 parts are delivered within forty-eight hours after ordering the dies.

A few of the stampings turned out by this concern are shown in the illustration. The parts at *A* and *B* are members of an electric switch. Part *A* was blanked and pierced at a cost to the customer of $19.50 for the first 100, and blank *B* at a cost of $16.25 for the first 100, delivery being made within forty-eight hours. At *C* and *D* are shown parts of a coin-operated machine. Part *C* cost $12 for the first 100, and part *D* $19.95 for the first 100. Both of these parts were delivered within twenty-four hours. Incidentally, the dies used in this work are not of the makeshift type, but are made of good tool steel and are accurate and durable.

The price of the first 100 parts includes the die cost, allowing the price of the remaining parts to be based on press operation and material.



Typical Stampings Made Economically in Lots as Small as One Hundred

Welding and Tungsten-Carbide Milling Discussed by Engineers

The Machine Shop Practice Division of the American Society of Mechanical Engineers held a meeting Thursday, March 17, in Newark, N. J., at which two papers of outstanding interest were presented. Everett Chapman, director of engineering research of Lukenweld, Inc., Coatesville, Pa., read a paper on "Welded Industrial Equipment with Reference to Machine Tools." This paper covered such phases of welded machine tool construction as weight reduction, stress distribution, prevention of fatigue failures, and importance of annealing. The paper was profusely illustrated with lantern slides and was ably discussed by a number of members. An interesting point made was that the objections sometimes raised to the appearance of welded machine bases and frames are largely caused by the habits of the mind. That which is familiar to the eye looks well proportioned; that which is new and unusual disturbs us.

"The Application of Tungsten and Tantalum Carbide to Milling" was the title of a paper presented by Frank W. Curtis, research engineer of the Kearney & Trecker Corporation, Milwaukee, Wis. This paper covered the basic rules that must be followed in the successful use of carbide milling cutters, discussed the direct and indirect savings, and suggested the best means for the care and maintenance of these cutters. This address was also profusely illustrated with lantern slides. Both papers constitute valuable contributions on recent developments in machine shop practice.

Milling with Tungsten-Carbide Cutters

Tungsten-carbide tools first found their widest application in turning practice, and for a long time it appeared as if these new cutting materials would not prove suitable for milling operations. All this has changed. Today a great deal of production milling is being done with tungsten-carbide cutters, and experiments are constantly being carried on that are widening the field of application. May MACHINERY will cover the application of these new cutting materials to the work performed on milling machines. Not only will a series of interesting experiments be recorded, but examples of the use of tungsten-carbide milling cutters in everyday shop practice will be placed on record. May MACHINERY will bring this subject up to date.

* * *

Meeting of American Welding Society

At the meeting of the American Welding Society to be held April 27 to 29 at the Engineering Society's Building, 29 W. 39th St., New York City, special attention will be given to welding in shipbuilding practice and to the ductility of welds. In addition, papers will be read on a number of other subjects, including a study of the transformation points of fusion weld metal; cause and cure of intercrystalline corrosion in austenitic steels; the welding of Duralumin, wrought-iron pipe, pressure vessels, light-gage metal, extruded metal, steam pipe and tube turns. Two papers will deal specifically with spot welding and with machine gas welding.

The American Tool Works Exhibition of High-Power Machine Tools

The demonstration and exhibition of new models of machine tools held at the plant of the American Tool Works Co., Cincinnati, Ohio, March 7 to 12, not only showed confidence in the early revival of industrial activity on the part of the manufacturer staging the exhibition, but also indicated the great interest that is being displayed by shop executives everywhere in the progress made in machine tool design. Several hundred works managers, equipment engineers, and superintendents visited the demonstration. The feature of paramount interest was the new American 22-inch, 100-horsepower super-lathe, which was demonstrated for the first time. This machine is described on page 620 of this number of MACHINERY. In addition, the visiting executives found twenty-three of the latest types of lathes, radial drills, and shapers on exhibition, these machines having been designed especially to meet the requirements of the speeds and feeds demanded by the newer types of cutting tools.

During the exhibition, cast iron, semi-steel and S A E 1045 steel, as well as nickel-alloy steel, were cut on lathes of various sizes with carbide tools. Radial drilling machine demonstrations included the drilling of various kinds of metal at speeds and feeds possible only on the latest type of modern drilling equipment.

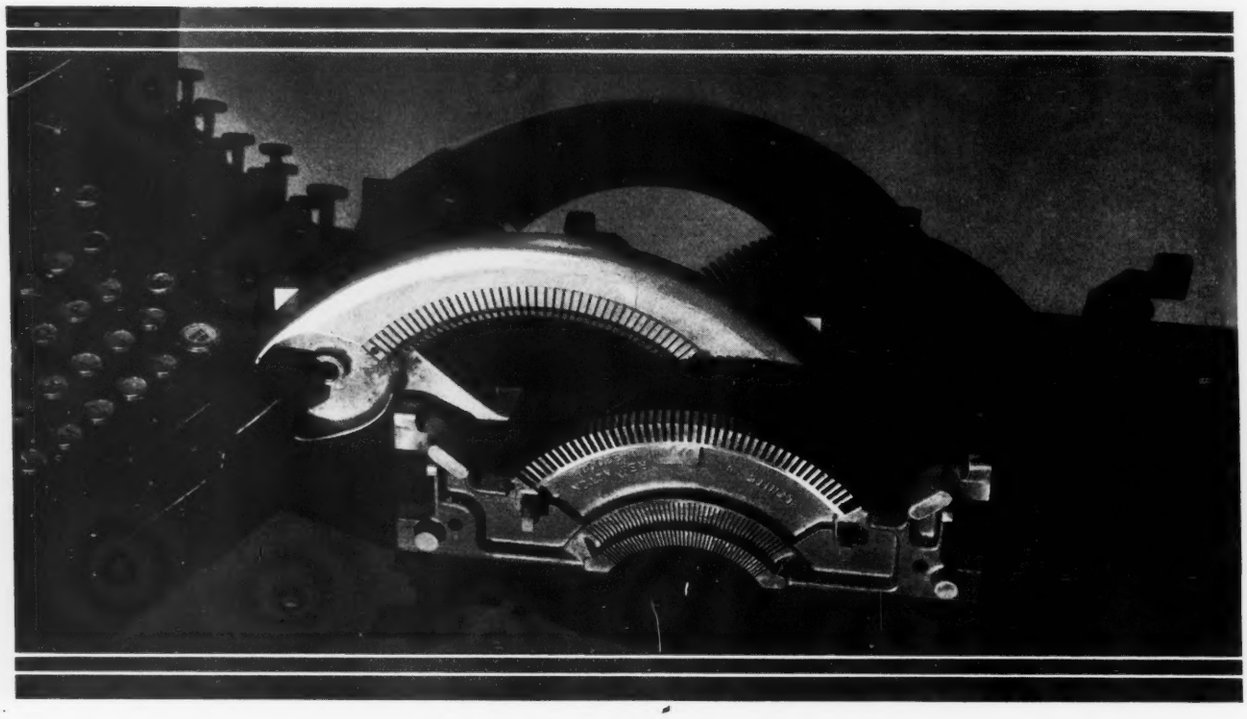
The interest shown in the exhibition indicated that shop executives are aware of the revolutionary changes that have taken place both in cutting tools and in the machines in which they are used. The quiet industrial conditions have been used by leading machine tool builders to advantage—they have produced equipment of a capacity that fully meets the improvements made in present-day cutting tools.

* * *

Is the Man Who Makes the Finest Drawing the Best Designer?

By J. A. ELSBERND, Cincinnati, Ohio

Referring to the question asked in the article on page 525 of March MACHINERY, "Is the man who makes the finest drawings the best designer?", I would answer "yes." A neat drawing, with good lettering and shading where necessary, is always easier to understand and check, and fewer mistakes are made in the shop.



Adapting Standard Machines for Automatic Milling

More and More, Machines of Standard Design are Being Adapted for Work Formerly Handled by Special Machines

WHENEVER standard machines can be applied to uncommon operations through the use of special auxiliary equipment, it is generally far more economical to follow this practice than to use single-purpose machines of special design throughout. Then, if the operation is later discontinued or changed, the standard machine can readily be applied to other work, whereas the special machine would probably become useless. The initial cost is another important factor to be carefully thought over in making such decisions.

Standard Machines Used for Milling Typewriter Segments

The accompanying illustrations show standard Cincinnati 18-inch manufacturing-type milling machines that were converted into inexpensive special-purpose machines for milling aluminum segments of noiseless typewriters. The special equipment illustrated and described is patented. Forty-five slots are milled in the upper segment casting seen in the heading illustration; forty-five slots are milled in the outer rim of the lower segment; and forty-four slots are milled in the inside portion of the same piece. The divisions between the slots are unequal in width, because the letters of the typewriter are of different widths, and yet the cumulative error in the spacing of all the slots is held to within 0.001 inch. This is a very close limit, considering the flimsy castings and the distortion produced in the pieces by slotting.

In adapting the standard milling machines for these slot-milling operations, the regular table of each machine was replaced by a special sub-table. This sub-table is fed by a power-driven cylindrical cam. The cam provides an automatic table cycle consisting of a rapid advance forward, a forward feed, and a rapid return. The cam bracket is bolted to the standard machine saddle, which was altered to suit. Power for driving the cam is delivered by the standard feed-fork shaft of the machine through a clutch. Thus, different rates of cam rotation can be obtained by standard feed change-gears.

A special circular table is mounted on the sub-table, and the work-holding fixture is mounted directly on the circular table. This table is indexed automatically by the cam-operated movement of the sub-table. Dog *A* in Fig. 1 automatically stops the entire mechanism at the end of each operation, when it depresses plunger *B* to disengage the feed-cam clutch. The work rests in the fixture on its previously finished base, and is located by two dowel-pins which fit into reamed locating holes. Two simple strap clamps hold the work firmly.

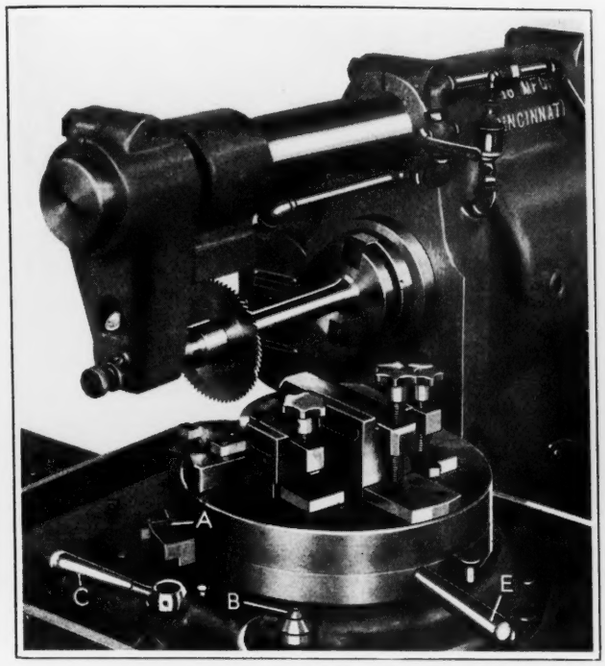


Fig. 1. Standard Milling Machine Arranged for Milling Unequally Spaced Slots in Typewriter Segments

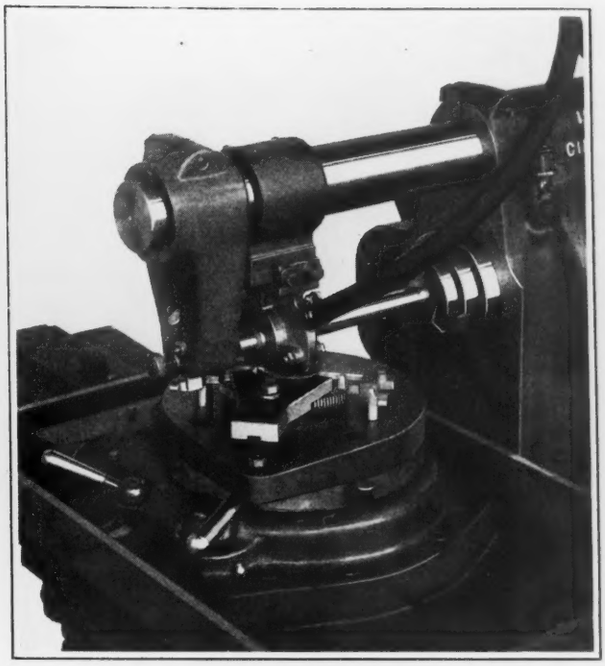


Fig. 2. Milling the Finer Slots on the Inner Side of the Same Segment Casting as Illustrated in Fig. 1

Fig. 1 shows the milling operation on the outer rim of the lower segment in the heading illustration. The saw, which is 5 inches in diameter by 0.073 inch thick, revolves about 260 times a minute, and the table feed is 7.35 inches per minute. The production per hour, under regular shop conditions, averages 9.4 pieces.

Fig. 2 illustrates the operation of milling the inner slots on the same piece. A saw 5 inches in diameter, and 0.027 inch thick, is used in this case, operating at a speed of 260 revolutions per minute. The feed of 2.9 inches per minute gives a production of approximately 2.86 pieces per hour. The guard seen over the saw in this illustration was especially designed to guide the delicate saw and prevent it from bending out of line in milling the slots.

Fig. 3 shows a third machine set up for milling the slots in the upper piece in the heading illustration. This machine is equipped with a different circular table and work-holding fixture. The equipment permits indexing of the work about an angular axis in such a way as to allow the cutter and arbor to clear obstructions in the segment being milled. The production on this operation averages five parts per hour, under regular operating conditions.

After the work has been loaded into the fixture in either of these machines, the clutch of the feed-cam is engaged by means of lever *C*, Fig. 1. From this point on, the work is automatically milled and indexed, leaving the operator free to run other machines. After the last slot in a part has been milled, the cycle is automatically stopped through the action of dog *A* and plunger *B*, as previously mentioned. The operator then removes the work and swivels the circular table by means of lever *E* back to the original loading position.

These examples of standard machines adapted to work for which special types might have been designed indicate the flexibility of standard equipment.

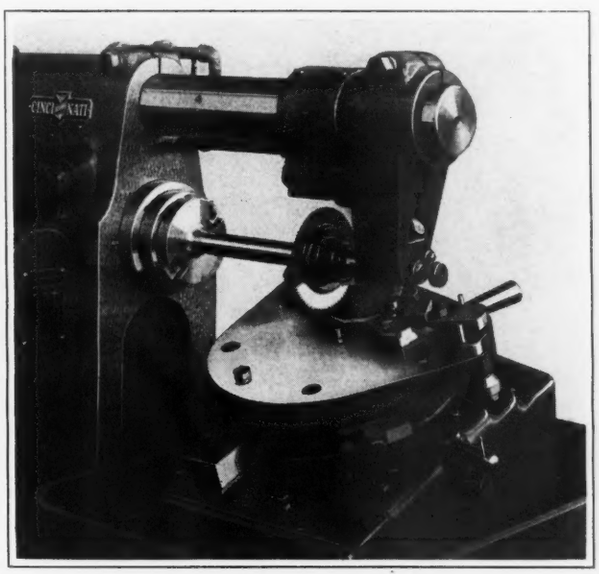
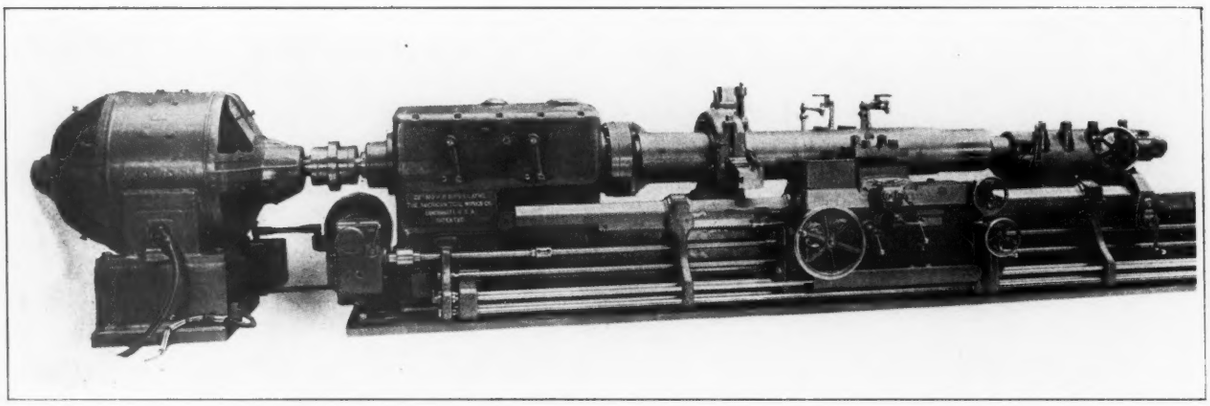


Fig. 3. A Slotting Operation Requiring a Circular Table Indexing on Inclined Axis



A 100-Horsepower Lathe for Testing the New Cutting Alloys

ORDINARILY, lathes of 22-inch swing are designed for a power input of about 15 horsepower, have twelve spindle speeds, and weigh approximately 8000 pounds. Compare such a standard machine with a "Super-Lathe" of the same swing, recently built by the American Tool Works Co., Cincinnati, Ohio. This lathe is designed for a 100-horsepower input, has a range of 140 spindle speeds from 33 to 1200 revolutions per minute, and weighs 40,000 pounds. It was built for one of the largest electrical manufacturers in the country, and is to be used for determining the maximum metal-cutting capacities of cemented carbide cutting tools.

A lathe of special design was found necessary for performing these tests on a variety of materials, such as non-ferrous metals and different grades of cast iron and steel, because the high power input and wide speed range, in combination with the necessary structural rigidity, were not available in a lathe of comparable size. The accompanying table gives data obtained in typical tests conducted in the lathe with various types of carbide tools on a nickel-alloy steel.

In addition to having increased power, range, and rigidity, this lathe embodies a number of new features in its construction. Two separate speed ranges are provided for the head, one being a high speed or direct range which provides seventy spindle speeds entirely through the 100-horsepower, direct-

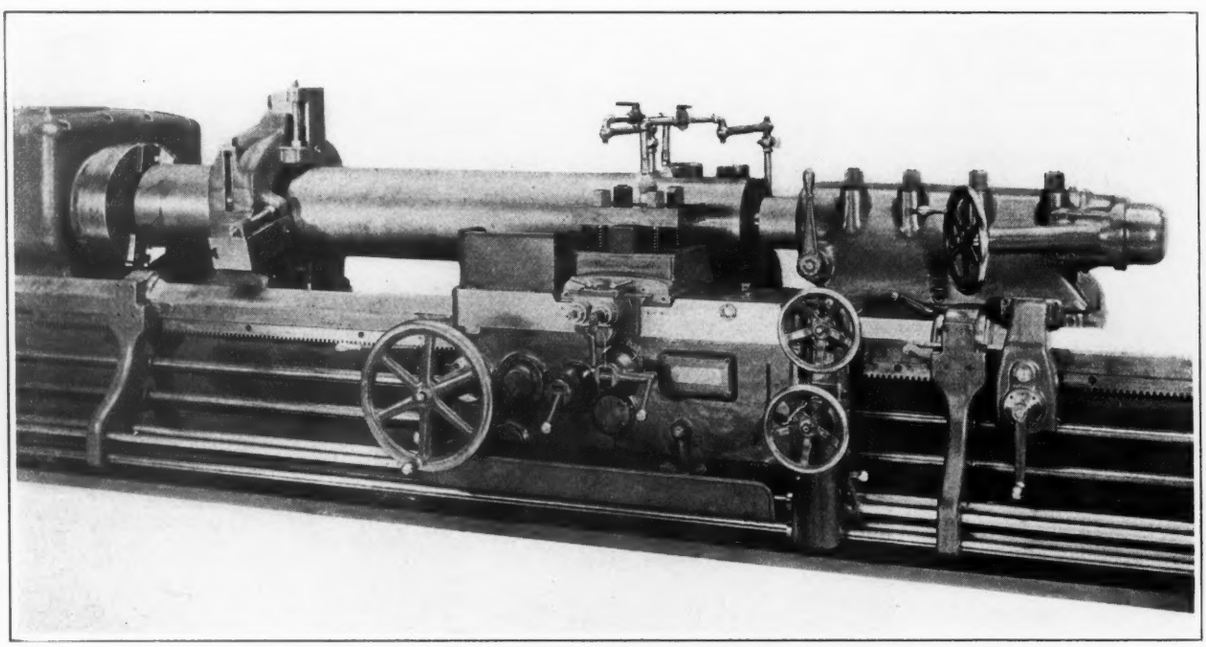


Fig. 1. Both the Carriage and Tailstock Have a Power Rapid Traverse through a Motor Mounted on the Tailstock End of the Bed

current, 6-to-1 motor. This speed range is controlled through the usual type of electrical apron mechanism. The second, or back-geared, range of speeds is of the same number as the direct range, and is obtained through four hardened and lapped helical gears carried by the spindle and an auxiliary shaft. An automatic interlocking mechanism is provided that prevents changing from direct to back-geared speeds without stopping the motor.

Data of Typical Tests on Carbide Cutting Tools, Conducted in the 100-Horsepower 22-Inch Swing Lathe

Diameter of Work, Inches	Cutting Speed, Feet per Minute	R.P.M. of Work	Depth of Cut, Inch	Feed, in Inches per Minute	Length of Cut, in Inches	Metal Removed, Cubic Inches per Minute	Horsepower Input
13 to 11 1/2	180	53	3/4	4	15	114	65
11 1/2 to 10	200	66	3/4	3.6	19 1/2	90	59
13 to 11 1/2	200	59	3/4	4.5	29 1/2	128	73
13 to 11 1/2	300	88	3/4	5.66	29 1/2	161	105
11 1/2 to 10 1/4	250	84	5/8	5.6	19	157	87

To provide maximum structural rigidity, the headstock bowl is cast integral with the bed. Both the spindle and the auxiliary shaft run in large-diameter Timken roller bearings at both ends and at the center. Every member of the head mechanism is automatically lubricated by filtered oil.

For strength and rigidity, the bed is made with a closed top, providing a complete box section. The carriage guides are faced with hardened steel strips. The rear flat guide-way is considerably below the two front vees, so as to give a decided slope to the top surface of the bed, in order to dispose of the chips rapidly.

The carriage, apron, and tailstock are all of unusually heavy construction. A rapid traverse mechanism driven by a two-horsepower reversible motor, mounted on the tailstock end of the bed, is an integral part of the apron. A lever at the left-hand side of the apron operates a reversible controller for starting, stopping, and reversing the rapid traverse motor. The front and rear tool-rests are massive steel blocks, with a capacity for 2- by 2 1/2-inch tools. There is also an auxiliary front rest for holding vertical tools.

Fig. 2. Chips Produced in the High-powered Lathe are Broken into Short Sections and Deflected into this Conveyor, which Carries them to a Receptacle at a Speed of 40 Feet per Minute

The chips produced in this machine would present a grave danger to the operator if they were not broken into short lengths. Therefore, a chip breaker and controller is provided, which not only breaks up the chips into small sections, but also deflects them into a conveyor. This conveyor carries the chips away at a speed of 40 feet per minute and deposits them in a removable collector bucket at the end of the conveyor. At the speed mentioned, the conveyor has a chip disposal capacity of 15 cubic feet per minute. The conveyor, which is illustrated in Fig. 2, will be installed in a pit beneath the floor level, and the three chutes will lead from the machine proper to the conveyor. The collector bucket will also be in the pit.

The tailstock has a weight of 4000 pounds, compared with the 250-pound tailstock regularly furnished with a standard lathe of the same swing. The tailstock unit can be traversed along the bed either manually, through gearing operated by means of a crank, or through the power rapid traverse mechanism. For power operation, the tailstock is connected to the carriage by a link.

One of the principal features of the machine is a feed mechanism that is entirely separate from and independent of the lathe spindle. This mechanism is driven by a three-horsepower, 6-to-1 adjustable-speed motor at the headstock end of the bed. Through a 50-contact rheostat and a two-speed mechanical unit, 100 rates of carriage feed are available from 1 1/4 to 43 1/2 inches per minute. A handwheel, revolving pointer, and graduated dial control the motor speed and indicate the rate of feed. The mechanical two-speed unit is also located at the headstock end of the bed and is connected to the feed-rod through a worm-gear speed reducer and a geared speed-change mechanism.

* * *

Symbols for mechanics, structural engineering, and testing materials have been approved by the American Standards Association as an American Standard. The standard consists of letter symbols for sixty-nine quantities commonly used in these fields.

Photo-Electric Tube Makes Weighing Scales Automatic

A weighing scale of the dial type is now available which is equipped with a photo-electric tube that automatically controls the valves, gates, or conveyors for filling containers with granular or liquid materials. This scale is a development of the Toledo Precision Devices, Inc., Toledo, Ohio.

The tube is located in the dial housing, an electric lamp outside the housing providing the necessary beam of light which passes through a slot in the dial.

In using the device, an adjustable indicator on the dial is set to the desired weight. The operator then merely presses a button to fill the container. When the required amount of material has entered the container, the mechanism operates the photo-electric cut-off, which closes the valve or gate. When the full container is removed from the scale, the valve or gate for filling the next container is opened automatically. For compounding or accumulating batch-weighing materials, multiple adjustable indicators are provided.

* * *

Hoist Manufacturers Elect New Officers

At the fifteenth annual meeting of the Electric Hoist Manufacturers' Association, held in New York City, March 17, William White, of the Euclid-Armington Corporation, Euclid, Ohio, was elected chairman of the Association, and Donald B. Patterson, of the Harnischfeger Sales Corporation, Milwaukee, Wis., was elected vice-chairman.

Manufacturers are Requested to Make Census Returns Promptly

The Bureau of the Census, Washington, D. C., requests that manufacturers who have not yet filled in their returns relating to their production in 1931, prepare and mail these returns promptly, thus aiding the Bureau in carrying out its plan to furnish preliminary reports in the near future.

Obviously, the value of these reports depends upon their being issued with reasonable promptness. The speed with which these reports can be published depends entirely upon the promptness with which manufacturers make their returns. If any manufacturer has mislaid the questionnaire sent him, he will aid the industry in obtaining prompt statistics by requesting another questionnaire blank and sending in his return at once.

* * *

Inventor of Swedish Gages Honored

C. E. Johansson, of the Ford Motor Co., inventor of the well-known Swedish precision gages—also known as the Johansson blocks—was presented March 5 with the John Ericsson Medal by the American Society of Swedish Engineers at the Society's headquarters, 271 Hicks St., Brooklyn, N. Y. The presentation was made in recognition of Mr. Johansson's contributions as a scientist and inventor to engineering and industrial developments. Mr. Johansson has lived in the United States since 1923, when he took charge of the Johansson Division of the Ford Motor Co. at Dearborn, Mich.

Do You Know

that a structural alloy metal is now produced that has a tensile strength up to 38,000 pounds per square inch and yet is 40 per cent lighter than aluminum? ***—see page 568.***

whether or not cast iron can be cut with the oxy-acetylene flame?—see page 572.

that rubber mountings are extensively used for absorbing vibration in all kinds of devices, from radio instruments used in aerial navigation to air compressors and motor-generators?—see page 561.

that welding is now applied in quantity production of pulleys up to 6 feet in diameter?—see page 576.

that by an optical inspection device, automotive poppet valves and similar high-precision parts can be accurately checked with a great saving of time? ***—see page 566.***

how the automobile industry avoids patent litigation?—see page 589.

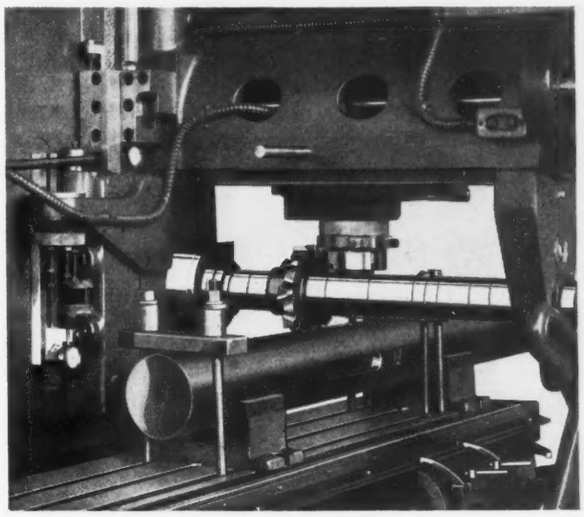
what the boracic-acid treatment is as applied to high-speed steel?—see page 592.

that X-ray photographs are now practical shop tools for the inspection of castings?—see page 593.

that steel castings are now made with a tensile strength of 80,000 pounds per square inch?—see page 601.

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts, and Material Handling Appliances Recently Placed on the Market

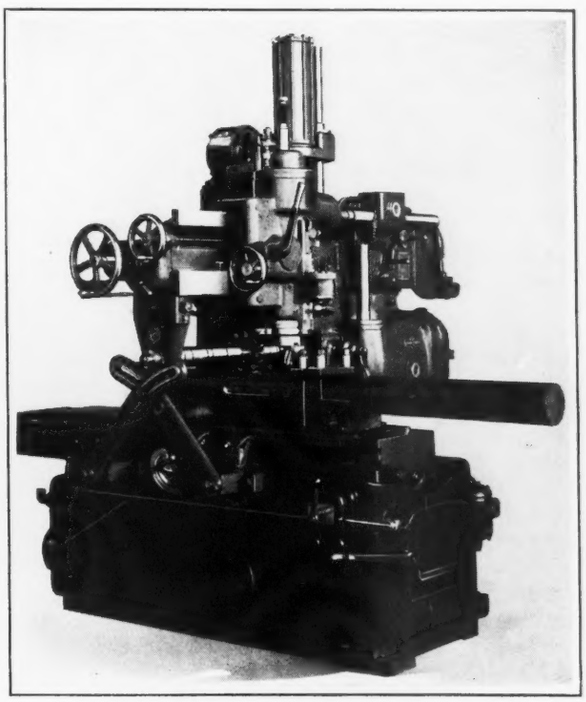


Cincinnati Keyway Milling Machine

Keyways can be milled in shafts from 1 to 18 inches in diameter by a machine, with patented features, being placed on the market by the Cincinnati Milling Machine Co., Cincinnati, Ohio. This machine is built from standard and semi-standard "Hydromatic" units. The straight section of the keyway is milled by a slotting cutter and the ends of the keyway are rounded at the same setting by an end-mill held in a vertical spindle.

All controls, including those for the table, spindle, and rail-assembly movements, are centralized at the normal operating position. The slotting cutter is raised out of the cut by power, aided by a hydraulic counterweight. The horizontal cutter-spindle is driven by a 10-horsepower motor, and the vertical spindle by a 5-horsepower motor. Any table feed up to 40 inches per minute is provided by the hydraulic equipment.

Twelve speeds ranging from 90 to 810 revolutions per minute are available for the vertical spindle. while the horizontal spindle speeds range from 20 to 150 revolutions per minute. Higher speeds can be provided if desired. Both the spindles have National standard taper holes.



Cincinnati Keyway Milling Machine for Cutting Small Round-end Keyways

The drive for the slotting cutter is the standard type, antifriction drive, with only four gear contacts, while the vertical carrier is driven by an independent motor mounted on the end of the rail. Speed changes for the vertical carrier are made quickly through sliding gears operated by control levers. The final drive is through spiral bevel gears.

Quick-acting clamps are provided for clamping the vertical carrier on the rail and the spindle in the carrier. The horizontal carrier and rail unit are clamped to the headstock by shifting the cam lever located just above the turret stop. Dial and turret stop arrangements are provided for both the horizontal and vertical carriers in order to insure accurate resetting of the machine for duplicate work. A graduated scale is mounted on the table chip guard for gaging the length of the keyway. Two pointers spaced 9 7/16 inches apart, which is the distance between the center

lines of the two spindles, extend over the scale.

Referring to the heading illustration, the lower dial indicator and turret stop are used to gage the depth of cut taken by the slotting cutter. The upper dial is employed for setting the rail preparatory to adjusting the vertical spindle to the correct depth for rounding out the end of the keyway. The milling machine is made in a number of sizes, with beds of any length required.

Brown & Sharpe High-Speed Milling Machines

A line of high-speed milling machines designed for economical milling with all types of cutters is being introduced on the market by the Brown & Sharpe Mfg. Co., Providence, R. I. These machines are especially adapted for operation at the high speeds required for efficient application of the new cutting alloys. The new line includes plain and universal machines of the column and knee type, in No. 2 and No. 3 sizes. Complete dual front and rear controls facilitate the operation of the machines and reduce the setting-up time. Power fast travel in all directions is provided to save time between cuts.

No clutch is used in these machines, the starting lever being arranged to operate the switch that controls the motor. The starting lever also controls a spindle brake. The hand adjustments at the rear of the table have graduated dials and are provided with safety devices that prevent the power feed from being engaged while the hand adjustments are in use. A longitudinal hand feed may be obtained by means of a crank or by a handwheel when fine adjustments are required.

The power fast travel for the table is available with the machine-driving motor running or stopped, as an individual built-in motor on the side of the machine operates the fast traverse mechanism. The same motor is used for driving the cutter coolant pump.

Thirty-two changes of spindle speed are provided, ranging from 20 to 1300 revolutions per minute. Thus the high speeds required for tool work and for a great variety of materials are available without using attachments. The required speeds are selected through conveniently located controls, the speed for which the controls are set being shown on a direct-reading dial. All speed gears are ground to give a smooth drive.

Thirty-two cutting feeds from 1/2 to 62 inches per minute cover the range of feeds customarily used for milling and also provide economical rates of feed for machining non-ferrous metals. Table feed changes are made from either the front or rear operating position. One revolution of either feed-lever, in either direction, accomplishes a change of feed in the series of feeds selected. The selection of

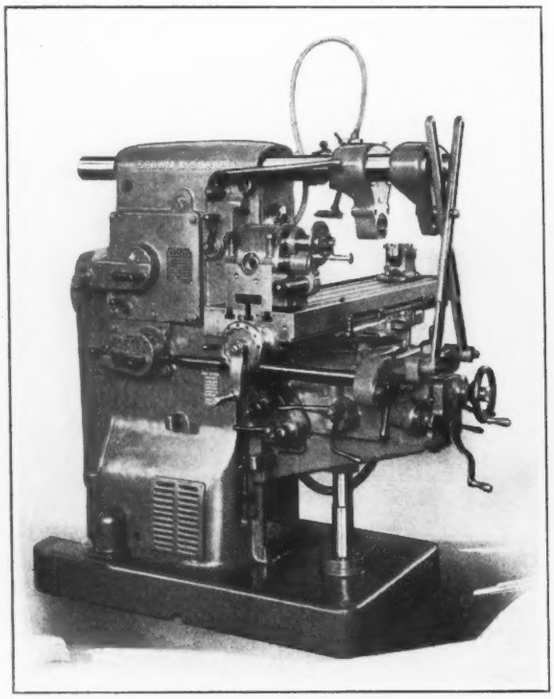


Fig. 1. Brown & Sharpe Universal High-speed Milling Machine

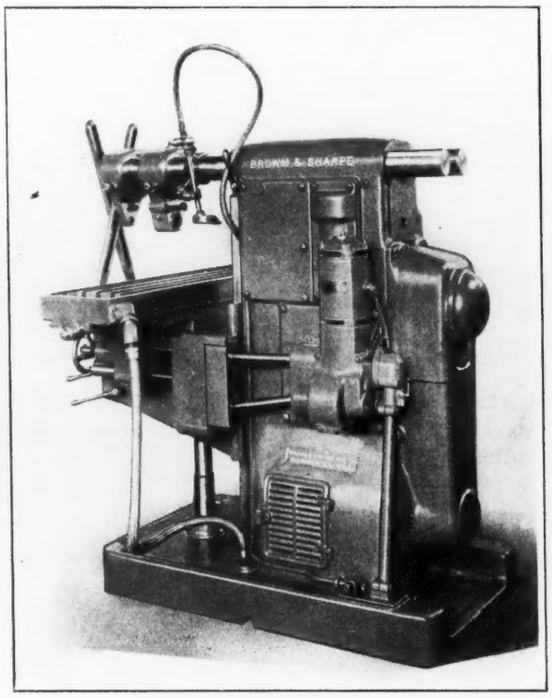


Fig. 2. Rear View of Plain Type High-speed Milling Machine

any desired series is made by means of a lever at the side of the machine. The rate of the longitudinal feed engaged is shown on a direct-reading dial, which can be clearly seen from either operating position.

The driving motor is enclosed in the lower part of the column. The chain guard and cover for the rear of the motor compartment are hinged to provide ready access to the motor and drive. The starting mechanism is placed above the motor and under the chain guard. All electric controlling mechanisms and wiring are thus enclosed. The built-in power fast travel motor is always sold with the machine, whether or not the main driving motor is included.

These high-speed machines have the customary Brown & Sharpe double over-arm construction, a standardized spindle end, a one-piece elevating screw, anti-friction bearings in all main mechanisms, and simplified oiling systems.

Toledo Press with Automatic Feed

An elaborate automatic roll feed is the outstanding feature of a press recently built by the Toledo Machine & Tool Co., Toledo, Ohio. In addition to the roll feed equipment, there are a number of special attachments and auxiliary devices for regulating the feed mechanism and for controlling the operations.

The press is of the double-crank type. The distance between the uprights is 39 inches and the bed area is 38 by 38 inches. The press has a stroke of 4 inches, and operates at a speed of 35 to 40 strokes per minute. The weight is 60,000 pounds. The press is equipped with a patented multiple-disk clutch having an independent brake and full automatic control. There is also an auxiliary operating handle at the extreme right of the press.

The sheet to be operated on is placed on the feed table, shown at the right in Fig. 1. This table is provided with adjustable gages to compensate for variations in the size of the sheets. The table support has a screw adjustment controlled by the handwheel at the front of the table. This adjustment provides for moving the table, the starting rolls, and an automatic starting gage into the proper position to allow a new sheet to enter through the oiling rolls.

From the oiling rolls, the sheet passes into the main feed-rolls, located within the housings and as close to the dies as possible. The feed derives its motion from an eccentric on the crankshaft, operating through a bellcrank. An adjustment enables any feed to be obtained at properly controlled intervals.

Motion is transmitted to the vertical rack *A* at the right-hand corner of the press, Fig. 2, for operating the discharge rolls. The vertical rack also operates the horizontal and inclined racks *B* and *C* seen at the front in the

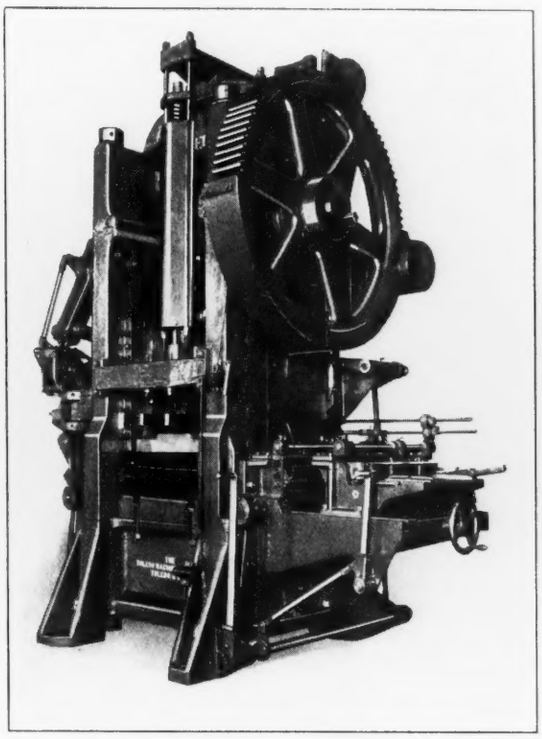


Fig. 1. Toledo Press Equipped with Automatic Roll Feed

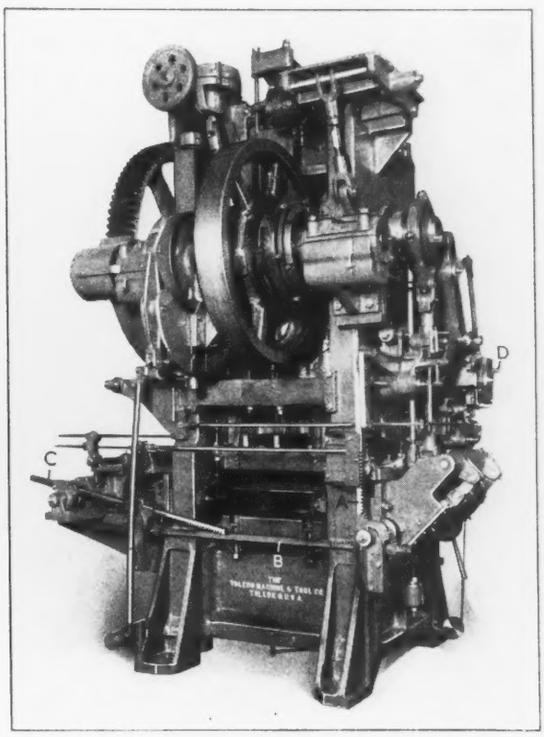


Fig. 2. Rear View of Press, Showing Roll Operating Racks

illustration. The latter racks operate the ingoing and starting rolls. Over-running clutches and brakes give a positive feed of any desired increment.

The rolls are released from the sheet at each stroke through the action of a cam on the crankshaft. A scrap shear, operated by the eccentric, is so designed that, by the removal of the gate and links, sheets can be passed through without being cut up. A vertical adjustment of 3 inches is provided for aligning the feed-rolls, table, and scrap shear with the dies.

After locating the indexing pin *D* of the control shown at the extreme right, Fig. 2, to agree with the number of blanks to be made in one sheet, and adjusting the length of feed and jump, the position of the starting gage, and the timing of the raising and lowering of the starting rolls, a sheet may be placed against the starting gage, after the starting rolls are raised.

The starting rolls drop and the gage is raised automatically, carrying the sheet through the oiling rolls and into the ingoing rolls. The ingoing rolls move the sheet across the die and into the discharge rolls, which positively feed the end of the sheet through the scrap shear. The last part of each sheet slides down out of the way. The finished pieces remain in the punch until the top of the stroke is reached, when they are ejected.

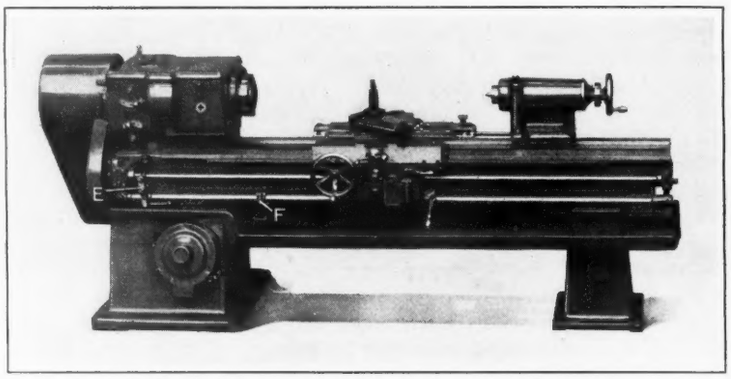


Fig. 1. Le Blond High-speed Production Lathe Designed to Use Cemented Carbide Tools

Le Blond "Ultra-Hi-Speed" Production Lathe

Spindle speeds from 150 to 2400 revolutions per minute are available in a heavy-duty, rapid production lathe developed by the R. K. Le Blond Machine Tool Co., Cincinnati, Ohio, for cemented carbide tools. The speeds from 150 to 600 revolutions per minute are obtained through helical back-gears, while the higher speeds are obtained through a direct drive to the spindle.

A six-sheave V-belt drive is used, as shown in Fig. 2. The driving pulley is supported between Timken bearings. The outboard bearing is mounted in a heavy bracket to insure accurate alignment of the pulley under the most severe operating conditions. When the spindle is driven direct, gear *A* is shifted to the right and acts as a splined coupling between the drive shaft and spindle *B*. This construction prevents the driving pulley load from coming directly on the spindle and thus eliminates vibration and wear. When gear *A* is in the direct drive position, flanges *C* and *D* are in line and it is impossible to engage the back-gears. This illustration shows gear *A* in position for using the back-gear train. The gear is shifted by means of a lever on the headstock.

The spindle is mounted in Timken bearings. It is unusually large, but is made shorter than usual, to prevent deflection under severe operating conditions. Forced lubrication is supplied to all headstock bearings.

All feed-gears are in the head-

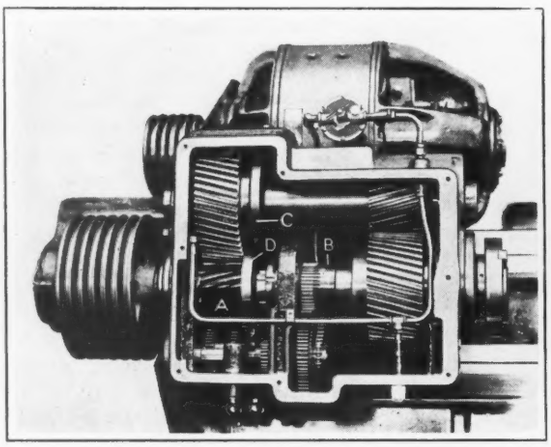


Fig. 2. Helical Gears are Used for the Back-gear Drive to the Spindle of the Lathe

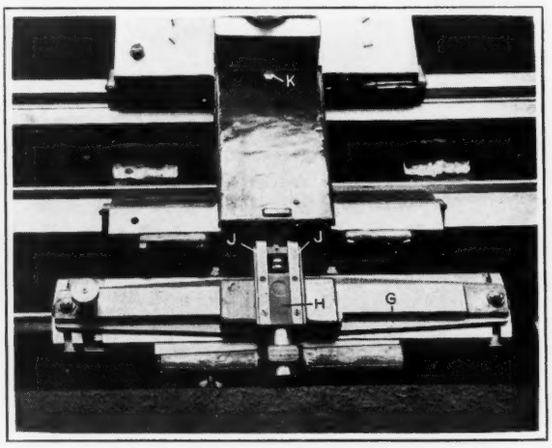


Fig. 3. The Taper Attachment is Designed to Facilitate Taking More than One Cut

stock, and they are mounted on Timken bearings. Nine feed changes are available, ranging from 0.002 to 0.025 inch per revolution. The feed-rod is mounted in two Timken bearings at the headstock end and in a straight roller bearing at the tailstock end. An automatic length stop at *E*, Fig. 1, consists of a positive clutch which is engaged when a boss on the apron comes in contact with adjustable trip-dog *F*.

The bed is a semi-steel casting equipped with hardened and ground Nitralloy ways. The entire front shear is made of Nitralloy, and the rear shear is a Nitralloy plate mounted on the bed. This feature prevents the bed from wearing in the sections where it is most used. The apron is equipped with an oil-pump which automatically lubricates the shears, the cross-slide, and the cross-feed screw bearings. The first stud and the rack stud are mounted on ball bearings.

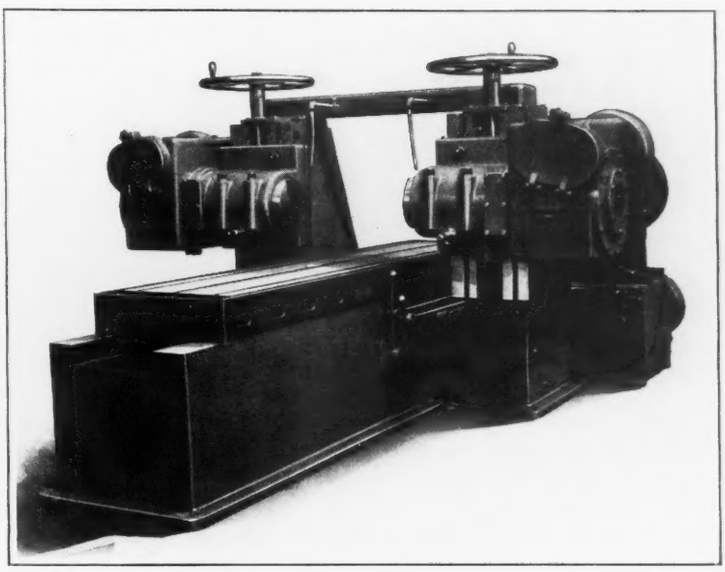
A taper attachment of improved design is provided. For purposes of rigidity, the guide bearings are reinforced by a heavy rib *G*, Fig. 3. Accurate alignment of the guide-bar shoe is insured by locating the bar near the center of the cross-feed screw and supporting it by the carriage shoe *H*, which, in turn, is supported between two bearings. The telescopic feed-screw is connected to one end of the carriage shoe. Two ball thrust bearings are used for this connection, in order to eliminate backlash.

Two draw-bars *J* are connected to the carriage shoe and extend under the cross-slide to a clamp in front of the compound rest. When more than one cut is desirable in turning tapers, this taper attachment construction makes it possible to use the cross-feed screw for adjusting the depth of cut. If a precision finish is not desired, it is unnecessary to use the draw-bars. When such a finish is wanted, the operator merely clamps the draw-bars by means of nut *K* for taking the finish cut.

The tailstock is of a special construction having a hardened and ground spindle that slides in a hardened sleeve, which is pressed in the extra heavy casting. A clamp of special design is used to locate the spindle in position. The construction is such that the spindle screw cannot back off and allow the center to loosen during an operation.

National Retaining Rings

A line of retaining rings or "artificial shoulders" of the type assembled in annular grooves turned in shafts, pins, and small cylindrical parts is being placed on the market by the National Lock Washer Co., Newark, N. J. This line includes standard stock sizes of rings for shafts from 3/16 to 1 1/2 inches in diameter. The rings are made in three types of sections, known as light, medium, and heavy, for each shaft size. Both square- and round-section rings, as well as open and closed types, are available.



Fitchburg Special Milling Machine Arranged for Repair Work in Locomotive Shops

Fitchburg Opposed-Head Milling Machine

A special milling machine recently built for a large railroad locomotive repair shop by the Fitchburg Engineering Corporation, Fitchburg, Mass., is shown in the accompanying illustration. This machine is arranged for repair work on locomotive crossheads and driving boxes.

Two milling heads of the self-contained power-unit type made by this company are incorporated in the design. These milling heads are so designed that they can be operated in any position. The spindle and the spindle driving member are mounted in Timken bearings. The spindle drive consists of a chilled, phosphor-bronze worm-wheel and a hardened and ground steel worm. The spindle speeds are varied by means of pick-off gears.

Bonney Extra Heavy-Duty Socket Wrenches

A series of extra heavy-duty socket wrenches, adapted for both automotive and industrial work, is being added to the line of wrenches made by the Bonney Forge & Tool Works, Allentown, Pa. This new series consists of fourteen hexagon sockets, with openings from 1 7/16 to 2 3/4 inches; two extensions, 9 and 18 inches in length; a sliding bar 22 inches long; and internal and

external driving heads. All this equipment is made with 1-inch square drives.

A No. XH set, consisting of seven sockets, with openings from 1 7/16 to 2 3/8 inches, together with extensions, sliding bar, and internal and external driving heads, is being put up in a metal carrying case, 23 by 5 1/2 by 4 1/2 inches in size. This set weighs 42 pounds.

A No. TD2 set of eight double-hexagon sockets, with openings from 5/16 to 3/4 inch, and accessories adapted for aviation and automotive use, is also furnished in a metal carrying case. Still another new product is an offset handle, No. 4086, equipped with a standard 1/2-inch drive. This handle is 10 inches long and has an offset of 3 inches.

Peerless Bevel-Gear Tooth-Rounding Machine

A machine developed especially for rounding bevel-gear teeth, in order to remove the knife-like edges of the teeth, which have a tendency to crack or chip in hardening or in service, has been brought out by the City Machine & Tool Works, 1517 E. 3rd St., Dayton, Ohio. The machine rounds the teeth as shown by the close-up view in the lower right-hand portion of the illustration. It is claimed that the smooth rounded corners eliminate the difficulties experienced in hardening and assure satisfactory service.

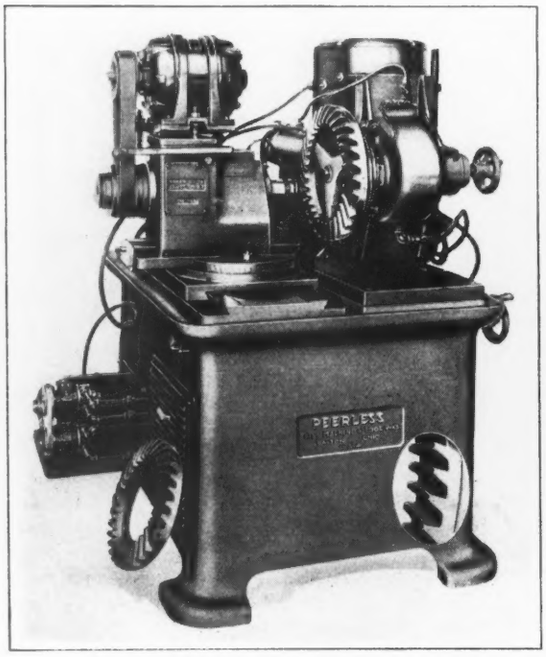
The machine is of rugged construction, and is designed for rapid operation. It is completely motor-driven, is self-contained, and accommodates gears up to 18 inches outside diameter.

Michigan Gear-Finishing Machine

A machine designed for finishing the teeth of gears that have been rough-cut in a previous operation is being placed on the market by the Michigan Tool Co., 7171 Six Mile Road, E., Detroit, Mich. As will be seen in Fig. 2, cuts are taken by a series of serrated blades arranged as a rack on a reciprocating table. The blades are spaced to suit the pitch of the gear to be finished, and have a form corresponding to the pressure angle of the gear. They are 3 1/2 inches wide and have serrations on each side for cutting the gear teeth on both sides. The work is held between centers, and is free to be turned by the engagement of the cutter rack with the teeth in the gear.

In an operation on helical gears, the cutter rack moves in a straight line at an angle to the gear axis corresponding with the helix angle. Thus, as the gear is revolved by the cutter rack, the gear teeth have a sliding contact across the cutter blades. Any predetermined amount of stock can be removed by regulating the number of table strokes and gradually feeding the work-head down to the proper depth.

On gears of 1-inch face width, it is customary to remove from 0.005 to 0.010 inch of stock on the tooth thickness. From one to fifty strokes can be made, after which the machine is stopped automatically. In order to insure uniform wear of the cutter blades, the work-head has an automatic sidewise movement upon the completion of each table stroke.



Peerless Bevel-gear Tooth-rounding Machine which Eliminates Hardening Difficulties

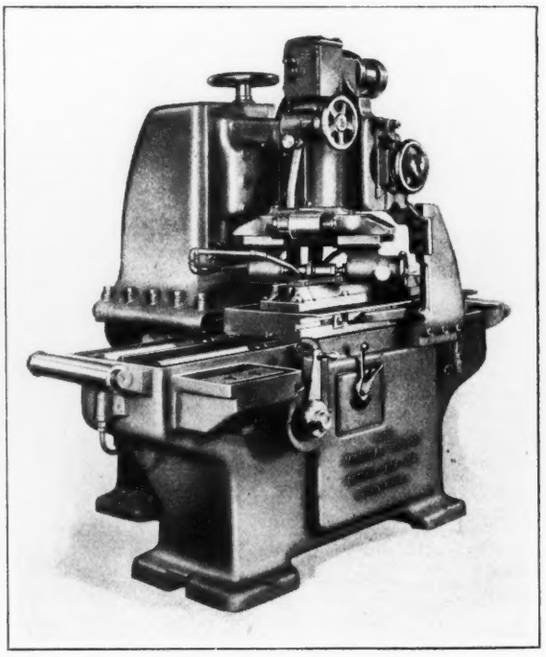


Fig. 1. Machine Developed by the Michigan Tool Co. for Finishing Spur and Helical Gears

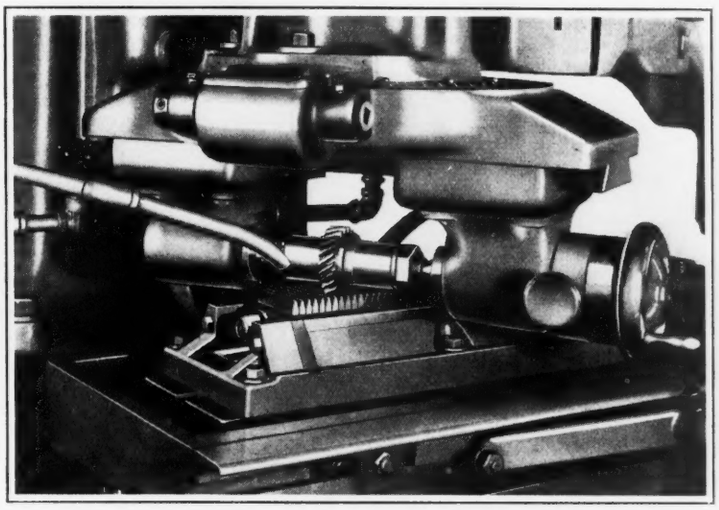


Fig. 2. Close-up View of the Serrated-blade Cutter Rack and a Helical Transmission Gear that is Being Finished

The machine is operated hydraulically through Oilgear equipment. After the machine has been loaded, the operator pushes a single lever to start the movement of the table and bring the head down to a predetermined position. When the table has made the desired number of strokes, the head is automatically raised and the table stops.

Gears of any helix angle, either right- or left-hand, can be finished with the same cutter rack, provided the pitch and pressure angle are the same. For cluster gears of different diameters and of close spacing, special cutter racks can be provided. However, if the cluster gears are one inch or more apart, they can be finished with a standard rack. Spur gears can also be finished by placing the cutter rack at an angle with the direction of the table travel.

In finishing 28-tooth 10-pitch helical gears having a 40-degree helix angle and a 3/4-inch face, removing from 0.004 to 0.008 inch of stock on the tooth thickness, the production averages sixty gears per hour, or one per minute. The life of the cutter rack for gears of this size is said to be at least 5000 gears per grind, and the rack can be reground 20 to 25 times. Gears up to 8 inches in diameter can be accommodated.

Automatic Plating Machine

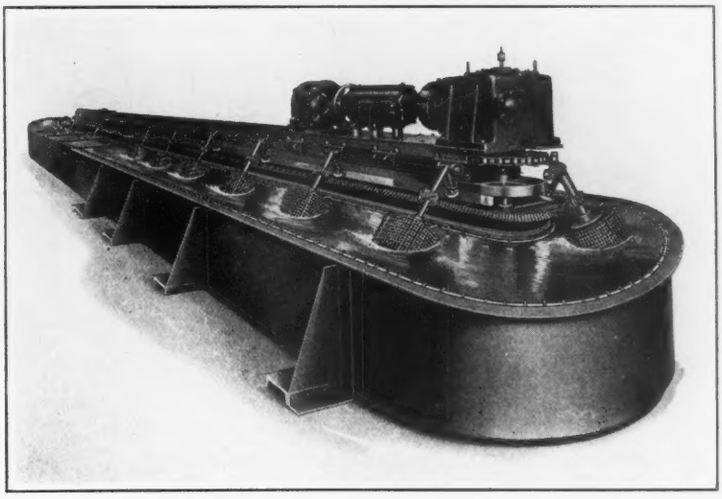
An automatic machine for plating small parts such as bolts, washers, and small steel stampings is being placed on the market by Frederic B. Stevens, Inc., Detroit, Mich. This machine is an invention of Albert H. Hannon, Springfield, Ohio, and is built by the Mitchell Engineering Co. of the same city. The parts to be plated are loaded into perforated drums made of insulating material, which, when loaded, are automatically conveyed through the cleaning, rinsing, plating, and drying compartments. When these operations are completed, the parts are automatically unloaded.

The work drums rotate while being carried through the various solutions, so that all the surfaces of the work are exposed to the anodes. The movement through the solutions, in addition to the agitation due to the revolving of the drums, causes the parts to pass continually through a new and enriched solution, thereby preventing hydrogen occlusion. The rate of travel, as well as the speed of drum rotation, can be varied to suit requirements.

The drums are removably attached to shafts which are pivoted on the conveyor chain. Pinions are keyed to each shaft which mesh with a rack that causes the drums to revolve as they are conveyed by the chain. Upon reaching the end of a tank, the drums are automatically lifted and lowered into the next tank.

Oxweld Bronze Welding Rod

A bronze welding rod known as "Oxweld No. 25 M Bronze Patented Welding Rod," has been introduced on the market by the Linde Air Products Co., 30 E.



Plating Machine that Cleans, Plates, Drys, and Unloads Small Parts Automatically

42nd St., New York City. This manganese-bronze rod is particularly suited for use in rebuilding wear-resisting surfaces, such as are required on piston-rings or cylinder walls. It is claimed that no fumes are produced when this rod is used, and that it is exceptionally free-flowing. It is made in three sizes—1/8, 3/16, and 1/4 inch in diameter.

Landmaco Pipe- and Nipple-Threading Machine

The 1 1/4-inch Landmaco pipe- and nipple-threading machine here illustrated has recently been placed on the market by the Landis Machine Co., Inc., Waynesboro, Pa. This machine is similar in design to one described in March, 1931, MACHINERY, page 552, but certain changes have been made in the carriage, bed, and die-head opening mechanism to adapt the machine for the production of pipe nipples. It is made in single- and double-head models and is equipped with either externally or internally tripped Landco pipe- and nipple-threading heads. The range of sizes handled by the externally tripped head is 1/8 to 1 1/4 inches, and by the internally tripped head, 1/4 to 1 1/4 inches.

A single-pulley drive with a friction-clutch control delivers power to the machine. The machine can be motorized at any time by mounting a motor in the bed compartment, connection with the drive shaft being made by a silent chain. Eight speeds are provided by the selective-type anti-friction-bearing gear-box built into the headstock.

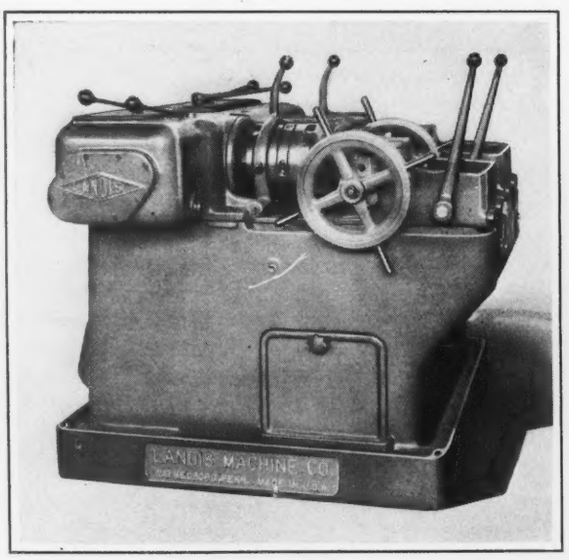
The spindle is driven by spiral bevel gears. The anti-friction bearings at the die-head end are over-size and are preloaded to eliminate end play. The die-head may be opened and closed either automatically or by hand.

The carriage is operated by a lever which can be located at either the right- or left-hand side of the carriage. The carriage guides are protected by guards and wipers, and are lubricated by felt pads fed with oil from a central reservoir. The vise has horizontal, sidewise, and vertical adjustments to enable the die-head and the work to be aligned accurately. The heavy rim of the handwheel that operates the vise acts as a flywheel and reduces the effort required to grip the work.

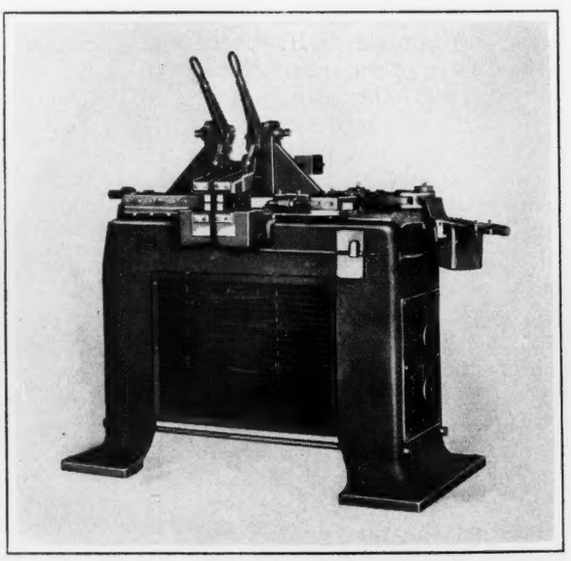
Lenney Light- and Medium-Capacity Butt Welders

Type B "Standard" butt welders designed to meet the needs of manufacturers who require light- and medium-capacity machines for production work have been brought out by the Lenney Machine & Mfg. Co., Warren, Ohio. Easily adjustable back-up and spacing arms are furnished on this machine as standard equipment. The welding lever on the hand-operated machines carries a contact switch operated from a thumb-latch, which permits turning the current on or off during the welding cycle. Another switch, which is located inside the frame, automatically breaks the circuit at a predetermined point.

The upset is accomplished by a single toggle movement. There is a die opening of 2 inches, and a total adjustment between the dies of 3 1/2 inches. The twelve-step current-regulating control gives both a wide range and a fine control over the current and voltage. The machine operates on single-phase current only, and is regularly furnished for 220- or 440-volt, 60-cycle current. It is built in 25 to 100 kilovolt-ampere capacities



Landmaco Threading Machine for Pipe and Nipples up to 1 1/4 Inches



Lenney Butt Welder Designed for Light or Medium Production Work

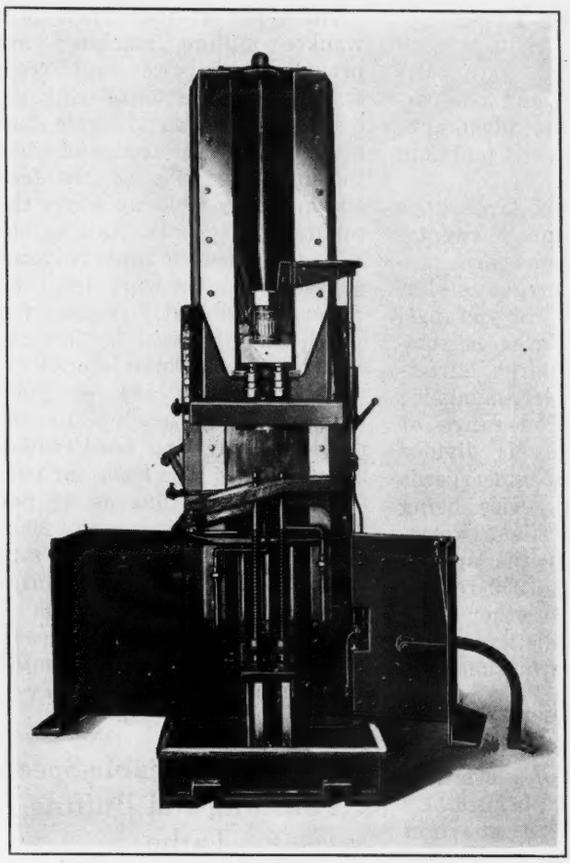


Fig. 1. American Broaching Machine which Operates One or More Broaches

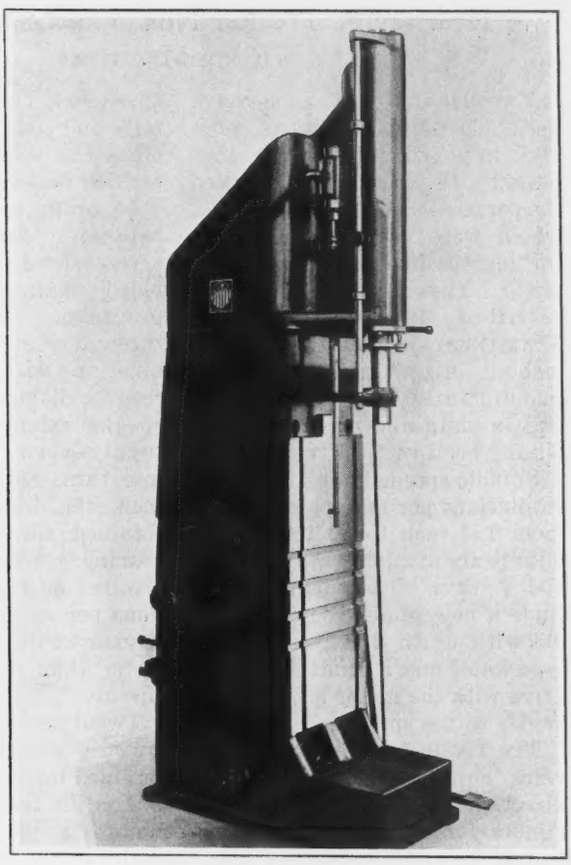


Fig. 2. American Hydraulic-feed Horning Press Made in 6- and 12-ton Sizes

American Broaching Machine and Horning Press

Two machines, a vertical broaching machine and a horning press, recently brought out by the American Broach & Machine Co., Ann Arbor, Mich., are shown in the accompanying illustrations. The V-42 semi-automatic vertical broaching machine, shown in Fig. 1, has a normal working capacity of 12 tons. It is designed to use broaches up to 42 inches in length, and will accommodate work up to 13 inches in diameter. The maximum cutting speed is 28 feet per minute, and the return speed 50 feet.

The machine can be equipped to operate one or more broaches at a time. The sequence of operations is as follows: The work is placed over the end of the broach shank, which projects through the angular table. Pressure is then applied to the foot-pedal, causing the lower cylinder to raise the broach rapidly and automatically connect it with the pull-head. Immediately upon pressing the foot-pedal, the operator starts the cutting stroke by pulling down on the hand-lever. On being connected with the pull-head, the broach is pulled up through the work.

After the broach has passed through the work, the pull-head is stopped by dogs which are set to give the desired stroke. The work drops from the broach and slides off the angular table into a receptacle. The machine is next reversed by means of a hand-lever. When the automatic head reaches its lower position, it instantly releases the broach, allowing it to drop 6 to 7 inches into the lower receptacle. This gives the broach a slight shock, which, aided by the flood of oil passing around the broach, serves to remove the chips.

The horning press, shown in Fig. 2, has been brought out as a standard machine and is built in two sizes of 6- and 12-ton capacities. The machine is operated by a hydraulic feed, the pumping unit being located in the rear of the column. The pumping unit is equipped with a built-in relief valve and volume control for varying the speed of the ram. The four-way balanced piston valve is controlled by a foot- or hand-lever. Adjustable dogs can be set for any desired length of stroke. A direct-reading gage on the right-hand side of the machine indicates the operating pressure.

The end of the ram is tapped to receive standard connections. The front face of the column and floor plate are machined for fixtures or special tables of the various forms that can be supplied. The downward speed of the 6-ton press is 20 feet per minute, and that of the 12-ton press, 24 feet per minute.

Kearney & Trecker Nos. 3 and 4 Knee-Type Milling Machines

Two sizes—Nos. 3 and 4—have been added to the line of new-style knee-type milling machines built by the Kearney & Trecker Corporation, Milwaukee, Wis., which were first introduced on the market in the Nos. 1 and 2 sizes. These machines were described in August, 1931, MACHINERY, page 957. Each size is built in universal, plain, and manufacturing horizontal types, and in plain and manufacturing sliding-head vertical types.

Spindle speeds from 12 to 1200 revolutions per minute and feeds from 1/4 inch to 60 inches per minute are available in the Nos. 3 and 4 sizes. Other features include a new center-bearing spindle with worm drive, a sponson type knee, and a multiple V-belt drive with the motor set at right angles to the spindle.

The 100-to-1 speed range provides surface speeds in either direction as low as 50 feet per minute for a 12 1/2-inch cutter and as high as 100 feet per minute for a 1/4-inch cutter. This broad range makes possible efficient performance with high-speed steel cutters, and also permits full use of the advantages offered by tungsten and tantalum carbide cutters.

In order to avoid large gaps between increments, twenty-seven speed changes are provided. They are in geometrical progression, and are obtained through a single lever in combination with a large direct-reading dial on the left-hand side of the column. The range of twenty-seven speeds is divided into three series of nine speeds each, the highest series being obtained through silent worm-gearing. Although the spindle revolves as fast as 1200 revolutions per minute, no other shaft or gear in the spindle train runs faster than 600 revolutions per minute.

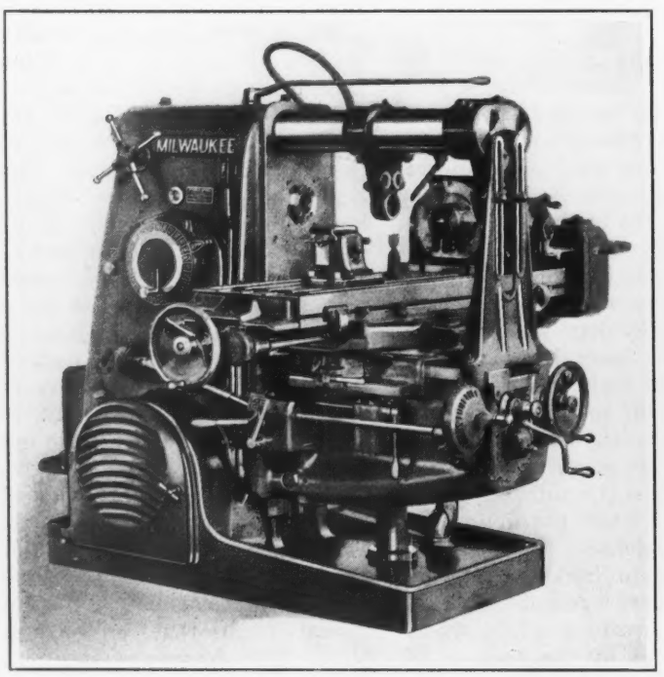
Twenty-seven changes of feed are also available, and they are obtained by means of a lever and dial on the front of the knee. By mounting the motor at right angles to the spindle, it has been made accessible from both ends, and it has been possible to strengthen the column.

All types of these new Milwaukee milling machines are provided with power rapid traverse in six directions. Engagement of the rapid traverse does not disengage the feed, and when the handle is released, the feed automatically picks up where the rapid traverse ends. As a safety measure, when the rapid traverse is used to run the work up to the cutter, the table dog releases the clutch and the feed is then re-engaged by a reverse lever.

The machines are equipped with a 14-inch swing hypoid bevel-gear dividing head, which is designed to give leads for cutting threads as fine as 38 per inch, as well as leads up to 2900 inches in one turn. Three sets of reversible worms and worm-wheels are included by means of which over 40,000 different leads may be obtained. Circular milling operations can be performed.

Hammond Variable-Speed Polishing and Buffing Lathe

A polishing and buffing lathe designed to provide the wide range of speeds required to



Kearney & Trecker New-style Knee-type Milling Machine Now Built in Two Additional Sizes

Hammond Polishing and Buffing Machine with Speed Adjustment to Suit Wheel Wear

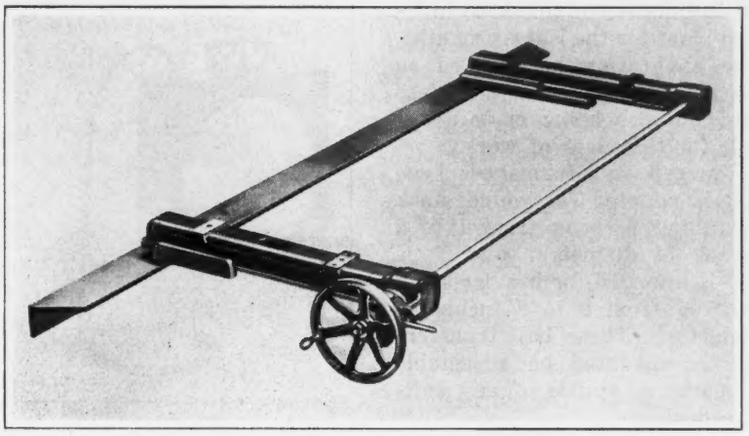


Fig. 1. Cincinnati Back Gage for Shear

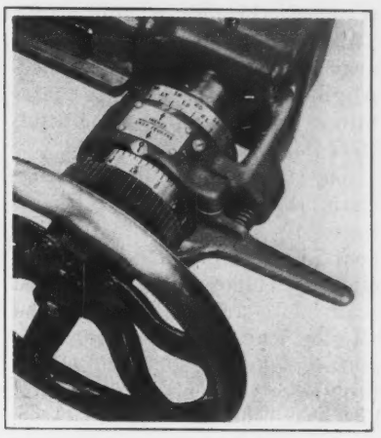


Fig. 2. Direct-reading Dial of Gage

maintain correct peripheral speeds under all conditions of wheel wear has been brought out by Hammond Machinery Builders, Inc., Kalamazoo, Mich. The V-belt drive used in connection with the Hammond variable-speed pulley enables the operator to change the speed in a moment's time to meet almost any requirement.

With this driving arrangement, speeds can be increased or decreased in increments of 25 revolutions per minute. Still finer speed adjustments can be made by using a variable-speed pulley on the motor, in addition to the one on the spindle, or by simply changing to a different size of motor pulley.

The standard machine has a solid pulley on the motor shaft and a variable-speed pulley on the spindle. The desired speed is obtained by expanding or contracting the variable-speed pulley. A vernier scale with letters corresponding to the speeds given on a chart mounted directly in front of the operator serves as a guide in selecting the desired speed.

These machines have the same general features as the "Rite-Speed" electric polishing and buffing lathes manufactured by this company. They are made in 3, 5, 7 1/2, and 10 horsepower sizes. A two-spindle type of machine with an independent spindle control is also made, in addition to the single-spindle machine illustrated.

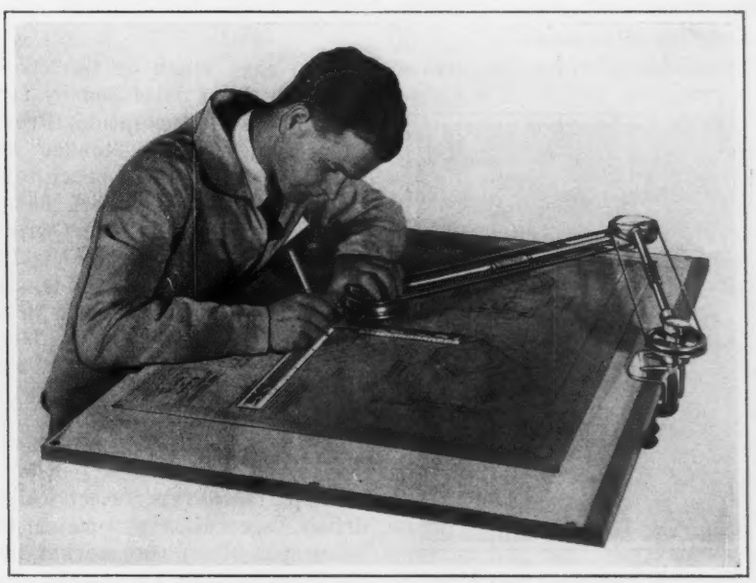
Cincinnati Direct-Reading Shear Gage

A back gage having a direct-reading dial has been brought out by the Cincinnati Shaper Co., Cincinnati, Ohio, for use on the "All Steel" shears of this company's manufacture, and is now standard equipment. This gage is ball-bearing equipped, and has the gear-operated adjusting screws connected to work in unison. When aligned parallel with the knives, the gage maintains its alignment for all settings.

One end of the straightedge can be adjusted outward independently of the screw to permit taper cutting. The gage bar is positioned by a stop when in the parallel position, and an automatic device locks the gage at any setting. The dial is graduated in inches and sixty-fourths of an inch.

Bruning-Wallace Drafting Machine

The drafting machine here illustrated is being placed on the market by the Charles Bruning Co., Inc., 818 Santee St., Los Angeles, Calif. It is so designed that the protractor head can be



Bruning-Wallace Drafting Machine with Protractor Head that Revolves through a Full Circle

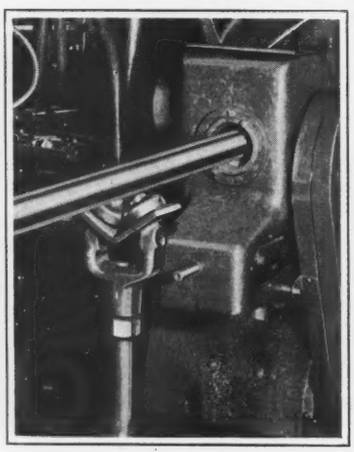
revolved through a full circle. This permits every part of the drawing board to be reached. Alignment of the head is maintained by three pulleys and a flat steel band.

The machine is ball-bearing-equipped throughout. It is secured to the table or drafting board by a clamp of heat-treated aluminum alloy. The tubes and scale plate are of "Dural," and all steel parts are of chromium-plated tool steel. The full-circle protractor is of nickel silver and has machine-cut graduations. Automatic stops are provided at the 0-, 30-, 45-, 60-, and 90-degree positions in all four quadrants of the protractor.

Ball Transfer for Supporting Bar Stock

The Mathews ball transfer, consisting of a large ball supported by smaller balls held in a cup base, was described in July MACHINERY, page 885. This transfer was designed primarily to facilitate the movement of sheets, plates, boxes, and other objects that have a smooth flat surface.

The accompanying illustration shows a pair of ball transfers, set at an angle, for use in feeding cold-rolled steel bars and tubing to a cutting-off machine. The Mathews Conveyer Co., Ellwood City, Pa., manufacturer of the ball transfer, has been using an installation of this kind in its own plant for the last six months. The application has proved so successful that the ball transfers are now also being made available for this class of work.

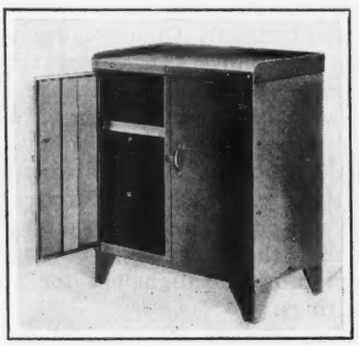


Mathews Ball Transfers Used to Support Tubing Fed to a Cutting-off Machine

Two types are furnished: Type 202 is adapted for round stock or tubing ranging from 1 to 3 inches in diameter; and Type 500 is intended for heavier stock ranging from 3 to 8 inches in diameter. These ball transfers can be mounted on adjustable supports or stands of any suitable design.

Stackbin "Machine Tender"

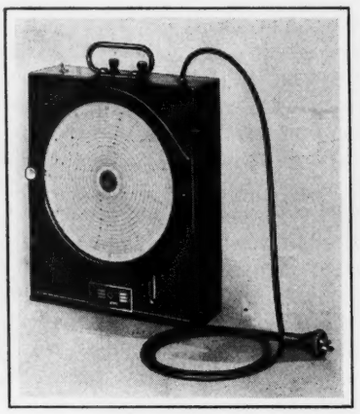
An enclosed-type sheet-steel "machine tender" or cabinet for storing tools, dogs, chucks, etc., within easy reach of the operator, has been developed by the Stackbin Corporation, Providence, R. I. This "tender" is equipped with a shelf, bench top, two doors, and a padlock hasp. It can be supplied with or without casters. The "tender" is 18 inches deep, 30 inches wide, 32 inches high, and is finished in a soft green color.



Stackbin "Machine Tender" for Storing Tools within Easy Reach

Hoskins Portable Recording Pyrometer

A portable type, electrically driven, recording pyrometer is being placed on the market by the Hoskins Mfg. Co., 4439 Lawton Ave., Detroit, Mich. This pyrometer weighs only 17 pounds, and can be easily mounted on walls and removed. The chart is driven by a self-starting, synchronous electric clock movement. It is of the circular type, 8 1/2 inches in diameter, and provides for recording the temperature over a twenty-four hour period. A series of overlapping dots records the temperature every thirty seconds. These dots are impressed by a stylus on carbon paper at the back of the chart. The meter is equipped with automatic cold-end compensation and is calibrated for Chromel-Alumel thermocouples.



Hoskins Portable Recording Pyrometer

Tube Timing Control for Welding Equipment

A timing device for spot, projection, and other forms of resistance welding has been placed on the market by Cutler-Hammer, Inc., 264 N. 12th St., Milwaukee, Wis. The electronic tube employed in this device makes it possible to time the welding operation to within a fraction of a second. Any required time adjustment up to 16 seconds may be obtained.

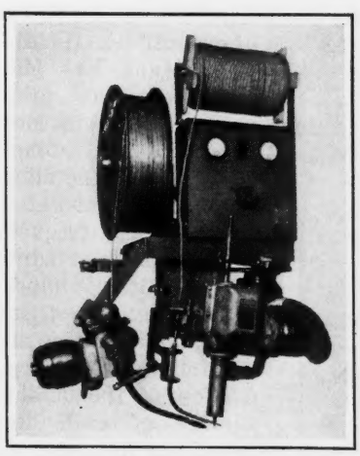
It is claimed that this close adjustment enables unskilled operators to produce successful welds with practically no rejections. The timing is adjusted by a knob inside the enclosing case. The device can be operated on 110- to 550-volt alternating current of 25 to 60 cycles.

Automatic Head for Shielded Arc Welding

A wire-feeding head that enables automatic welding to be done by the shielded arc process has been developed by the Lincoln Electric Co., Cleveland, Ohio. This head is intended for high-speed operation in either butt, fillet, or building-up welding. The principal advantage claimed is that the deposited metal has physical characteristics equal to or better than those of mild steel.

The advantages of the shielded arc process are secured through the use of an "Electronic Tornado" welding head and a fibrous autogenizer which is fed into the arc flame. This autogenizer burns and forms a gas that excludes the oxygen and nitrogen of the atmosphere while the metal is molten. The welding head utilizes a carbon arc around which there is a magnetic field that directs the arc stream on the line of fusion. The heat of the arc is constant, because of the fully automatic arc control.

Filler metal is fed into the arc from a reel on the head. The feeding rate of the filler metal may be varied so as to deposit the metal to suit conditions. Only one size of filler metal is necessary for any work within the range of the machine. The filler metal is usually in strip form to insure accuracy in feeding it.



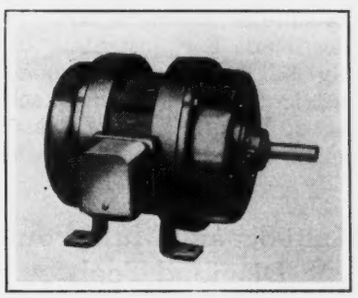
Lincoln Wire-feeding Head for Automatic Welding by the Shielded Arc Process

As no current is carried by the filler metal, its size does not depend upon the current used for welding, and spatter and waste are largely eliminated.

It is claimed that welds made by the shielded arc process have a tensile strength ranging from 65,000 to 80,000 pounds per square inch, and a ductility or elongation of 2 per cent or more in 2 inches.

Imperial All-Steel Induction Motors

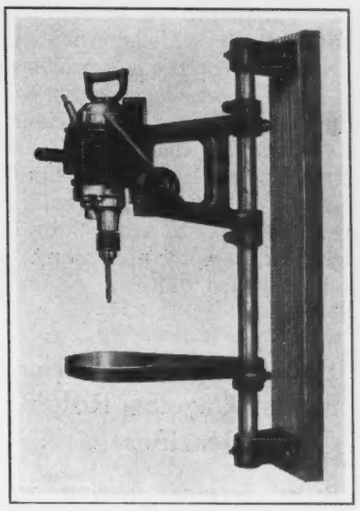
A line of squirrel-cage alternating-current induction motors of all-steel construction, with pressed-steel end-bells, has recently been placed on the market by the Imperial Electric Co., Akron, Ohio. These motors have no cast parts, with the exception



Imperial All-steel Ball-bearing-equipped Induction Motor

of the bearing "cartridges" which house the ball bearings. The same pressed-steel end-bells are used when the motors are equipped with sleeve bearings.

The end-bells are made by the Variety Machine & Stamping Co., 3404 Tate Ave., Cleveland, Ohio, who also designed and built the die equipment that is used in their production. The end-bells are proportioned to give maximum rigidity under all working loads and to balance or neutralize any internal stresses that may be set up in the forming and drawing operations. The result is a uniform and lightweight structure that can be quickly and easily machined within close limits and that holds its shape in service.



Post-type Radial Drill Stand for Hisey Portable Electric Drills

Hisey Post-Type Radial Drill Stand

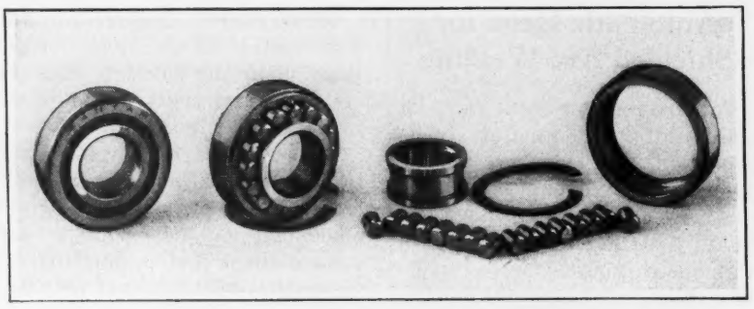
The post-type radial drill stand here illustrated has been brought out by the Hisey-Wolf Machine Co., Cincinnati, Ohio, for use with all Hisey portable electric drills up to and including those of 7/8-inch capacity. This stand is equipped with a sensitive rack-and-pinion feed. The motor-holding brackets are so designed that the drill can be attached without removing any part of the machine.

The vertical movement obtained by means of the lever through the rack and pinion is 7 1/2 inches, and the vertical adjustment on the main column is 19 inches, giving a total vertical adjustment of 26 1/2 inches. The maximum reach from the column to the drill spindle is 13 inches. The net weight of the stand is 140 pounds.

Vacuum-Cup Metal Pulleys

A line of pulleys in which vacuum is employed to obtain a firm grip between the belt and the pulley is being placed on the market by the Keystone Engineering Co., Inc., 850 Maccabees Bldg., Detroit, Mich. The principal feature of this line of KE-CI pulleys is the provision of

spherical-shaped recesses on the faces. It is claimed that the vacuum grip on the belt produced by these recesses prevents belt slippage, increases the efficiency of power transmission, and lengthens the life of the equipment. The pulleys are regularly available in sizes from 3 to 16 inches in diameter and from 2 to 14 inches face width.



Bantam "S A E Metric Series" Roller Bearing Made without a Cage to Enable the Maximum Number of Rollers to be Used

Bantam "S A E Metric Series" Cageless Roller Bearings

Roller bearings having outside-diameter, bore, and width dimensions that conform to the specifications of the "S A E Metric Series" ball bearings are being introduced on the market by the Bantam Ball Bearing Co., South Bend, Ind. These bearings are made without a cage, so as to enable the maximum number of rollers to be used between the races, thereby obtaining a high load-carrying capacity. With all the rollers touching each other, the space between the first and last rollers is only several thousandths of an inch. The load-carrying capacities of the new bearings are said to be from six to ten times greater than the capacities of similar size ball bearings made by the concern.

These radial roller bearings were developed especially for applications where the size of the bearing is limited. Other advantages, in addition to their high capacities, are quiet operation and suitability for use at high speeds. They can be run at speeds up to 12,000 revolutions per minute.

Only three parts, with the exception of the rollers, are embodied in the bearing construction. These comprise the inner and outer races and a flat spring clip that holds the rollers and races assembled. The circumferential edge of the clip enters a groove in the outer race, as will be apparent from the illustration. When one of these bearings is in service, any endwise thrust is taken on a shoulder of the inner race and transferred through the rollers to a shoulder on the opposite side of the outer race.

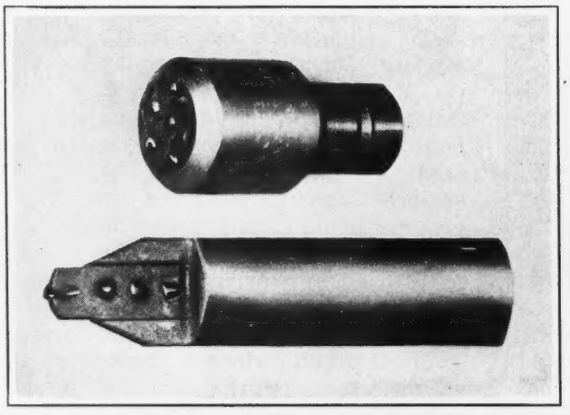
While these bearings were primarily designed for automobile generators and starters, they are suitable for many other applications. For instance, they may be employed in portable electric and pneumatic tools, electric motors, speed reducers, and machine-tool change-gears.

Multi-Set and Multi-Point Diamond Tools

Grinding-wheel dressing tools consisting of several small diamonds mounted in one holder for purposes of economy are being placed on the market by the Koebel Diamond Tool Co., 1200 Oakman Blvd., Detroit, Mich. At the bottom of the illustration is shown a Multi-set tool cut away at one end to expose the four diamonds embedded in it. As each of the diamonds is used up in dressing the grinding wheels, the metal of the holder is turned off or ground away to expose the next stone. This tool is applied to the grinding wheels at the usual 15-degree angle.

Seven small sharp stones are set in the face of the Multi-point tool shown at the top of the illustration. In practice, this tool is presented to the grinding wheel at an angle of about 3 degrees so that two to five of the diamonds are brought into contact with the wheel. Frequent turning of the tool in its holder will continually provide sharp corners, and each stone will take its share of wear. This tool is particularly recommended by the manufacturer for centerless grinding when a high finish is desired.

The alloy from which the tools are made has the same coefficient of expansion as the diamonds, and has high heat-dissipating properties. This avoids loosening of the stones, regardless of the alternate heating and cooling caused by frequent applications to grinding wheels. Other important advantages of this method of mounting are as follows: A large portion of the outside surface of each diamond can be used; all resetting cost and handling of diamonds are eliminated; losses



Diamond Wheel-dressing Tools with Multiple Number of Diamonds

Fig. 1. Stanley Screwdriver with Releasing Clutch Mechanism

Fig. 2. Sander with Flexible Disk for Smoothing Castings and Similar Work

Fig. 3. Saw which may also be Equipped with an Abrasive Disk

caused by the misuse of tools are reduced to a minimum, because the operator cannot accidentally damage the entire tool; and the process by which the diamonds are mounted exposes flaws not detected by visual inspection.

Stanley Portable Electric Tools

A screwdriver, sander, and safety saw have been added to the line of portable electric tools made by the Stanley Electric Tool Co., New Britain, Conn. Fig. 1 shows the screwdriver. It is equipped with a clutch mechanism designed to release at any pressure for which it has been set. This prevents driving the screws too deep into the wood, avoids marring the work surface or screw slots, sets the screws up tight, and eliminates the hazard of overloading the motor or stripping bolt and screw threads. The device weighs only 4 1/4 pounds, and will drive screws up to No. 8 in hard wood, and up to No. 10, 1 1/2-inch screws in soft wood. With socket wrenches, nuts up to 1/4 inch can be tightened.

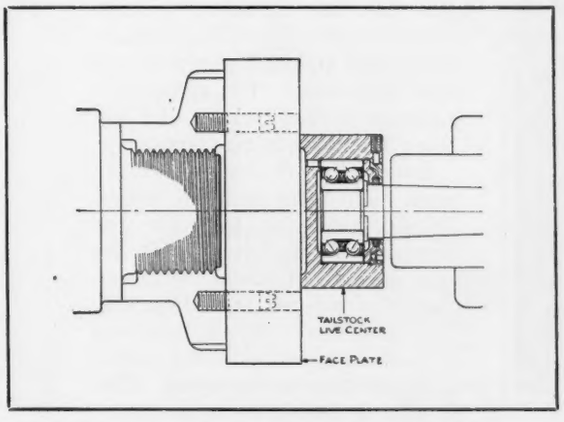
The sander, which is shown in Fig. 2, is intended for smoothing castings before and after filler is applied, for removing rust and paint, and for rubbing and polishing lacquered surfaces, etc. Seal-type bearings are used on the armature and spindle to exclude dirt, retain lubricant, and insure smooth operation. The 9-inch disk is flexible.

Fig. 3 shows the saw. It is equipped with a 6-inch blade having a capacity up to 1 7/8 inches in wood. By using an abrasive disk instead of the steel blade, the device can be used for cutting other materials, such as tile, stone, and slate. This tool has a weight of 14 pounds.

Red-E New Departure Live Center

The Ready Tool Co., 550 Iranistan Ave., Bridgeport, Conn., has recently made an adaptation of the Red-E New Departure live center which permits the complete turning of work in one setting, even though the work cannot be held on an arbor. From the illustration, it will be seen that this center has a special head, quite large in diameter, which is used to hold the work firmly against the faceplate of the lathe. The side of the head that comes in contact with the work is relieved, except for a face about 3/8 inch wide around the rim. A preloaded ball bearing within the special head permits of holding the work safely against the faceplate for the turning operation.

The work is generally driven by entering a driving pin held on the faceplate into a hole drilled in the end of the work fairly close to the periphery.



Live Center Designed for Holding Work against Faceplates

Cutler-Hammer Starters for Synchronous Motors

A new line of automatic and semi-automatic starters for synchronous motors has been brought out by Cutler-Hammer, Inc., 264 N. 12th St., Milwaukee, Wis. These starters have a frequency responsive relay which functions in connection with an adjustable time-delay thermal overload relay.

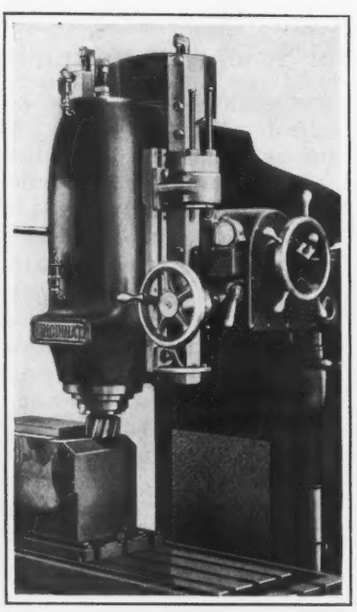
In case of a heavy overload, reduced line voltage, failure of the motor field, or loss of direct-current excitation, the frequency relay disconnects the field switch and permits the motor to operate as a

squirrel-cage motor for a period of about thirty seconds. Should normal conditions return within the time adjusted for, the motor will resynchronize and continue in operation; otherwise, it will be disconnected from the line. These starters are made in sizes of from 25 to 600 horsepower.

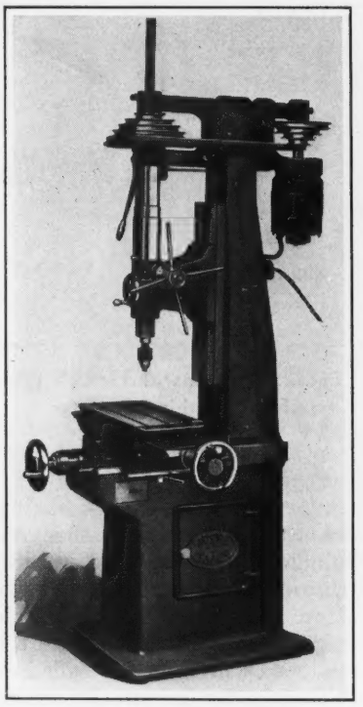
Four-Position Turret Stop for Milling Machines

A patented, four-position turret stop and dial indicator has been brought out by the Cincinnati Milling Machine Co., Cincinnati, Ohio, as standard equipment for the new designs of Nos. 1, 2, and 3 knee- and column-type milling machines of this company's manufacture. The stop provides for quickly setting the spindle to different positions for step-milling and also facilitates jig-boring and die-sinking.

The turret and its four adjustable stops can be turned easily by hand in either direction. With this arrangement, the power feed to the milling machine head is automatically disengaged when the cutter has milled to within a few thousandths of an inch of the desired depth. The final setting is made by hand with the aid of the dial indicator.



Cincinnati Four-position Stop for Milling Machines



Moore Jig Borer with Speeds from 200 to 2000 R.P.M.

Moore Jig Borer

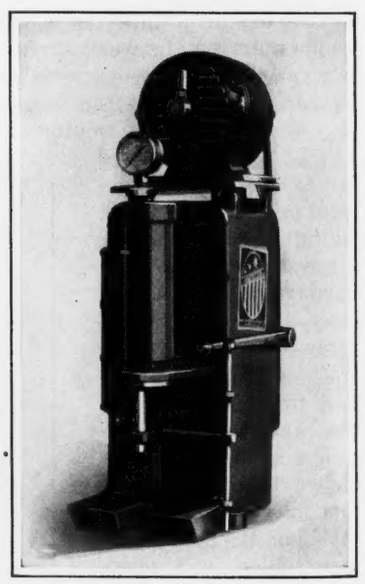
A jig boring machine having ample capacity for drilling and boring holes in tools, dies, jigs, and fixtures, such as are used in the manufacture of locks, typewriters, cameras, small electrical appliances, radio parts, and other products of a similar size, is being placed on the market by the Moore Special Tool Co., Inc., Bridgeport, Conn. Measurements between holes are taken by means of precision lead-screws. These screws are of large diameter and are made of a wear-resisting alloy steel. The threads are lapped and each screw is kept well lubricated. The screws are entirely covered to keep dirt and chips from reaching them.

Taper gibs are used in both the cross and longitudinal slides. Special provision is made for clamping the slides so that the gibs are not affected and the accuracy of set-ups is maintained. The tool-steel spindle revolves in five ball bearings, three in the quill and two in the pulley. The spindle is driven by a ball-bearing, vertically mounted, 1/3-horsepower motor having a speed of 1200 revolutions per minute. A V-belt and a five-step aluminum cone pulley are used for the drive.

A large bracket for slip guide bushings (not shown in the illustration) can be furnished for drilling and reaming operations in the manufacture of small quantities of parts. The machine can also be provided with a rotary table. The longitudinal movement of the machine is 14 1/4 inches, and the crosswise movement 9 1/8 inches. The vertical travel of the quill is 3 5/8 inches, the maximum distance from the spindle to the table being 15 inches. The spindle speeds range from 200 to 2000 revolutions per minute. Holes up to 1 1/2 inches in diameter can be bored in tool steel.

American Hydraulic Bench Press

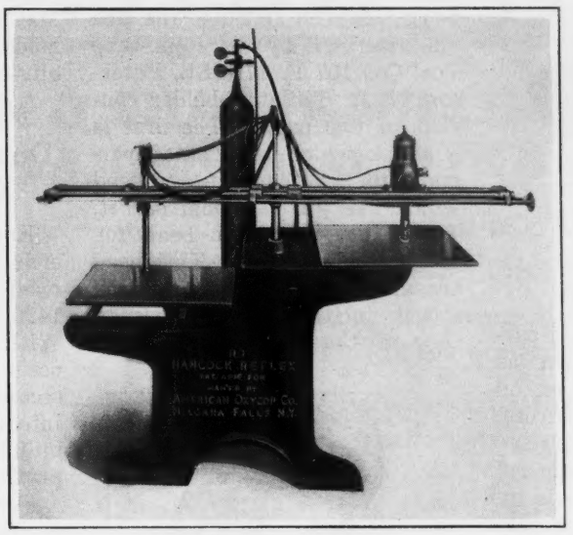
A hydraulically operated bench press of 1/10-ton capacity, known as the Type V-000, has been brought out by the American Broach & Machine Co., Ann Arbor, Mich. The ram of this press operates at a speed of 90 feet per minute and has a return speed of 120 feet per minute. When the hand-lever control is released, the ram returns auto-



American Hydraulically Operated Bench Press

matically to its starting position. The maximum length of stroke is 5 1/4 inches, but any desired length of stroke up to the maximum can be obtained by adjusting stop-dogs.

The "American" built-in pumping unit, the four-way control valve, the relief valve which can be varied to give any pressure up to the maximum capacity of the machine, and the operating-lever shaft are all mounted in a flanged panel which can be removed to make the entire assembly easily accessible. The machine is arranged for a motor drive only through "Texropes." A 1/2-horsepower motor, operating at a speed of 1800 revolutions per minute, is recommended. A direct-reading gage shows the pressure on the ram in pounds per square inch.



Machine Made by the American Oxycop Co. for Cutting Metal with Natural, Coal, or Butane Gas

"Oxycop" Gas Profile-Cutting Machine

The Hancock "Oxycop" machine here illustrated, which is designed primarily for tool-room use, is intended for cutting metals to various outlines by using natural gas, coal gas, or butane gas. The machine is being placed on the market by the American Oxycop Co., Niagara Falls, N. Y. It is especially designed for cutting operations on dies, cams, stripper plates, jigs, etc., and can be operated by hand, automatically or semi-automatically. The machine is fitted with a universal head, which can be equipped for producing intricate dies or irregular shapes from drawings.

The coal-gas burner uses ordinary illuminating gas and oxygen. Gas with a calorific value as low as 500 B.T.U. can be used under normal pressure without requiring the use of a booster. It is claimed that steel remains unchanged after cutting, being neither carburized nor decarburized. Cutting speeds ranging from 3 to 12 inches per minute can be employed.

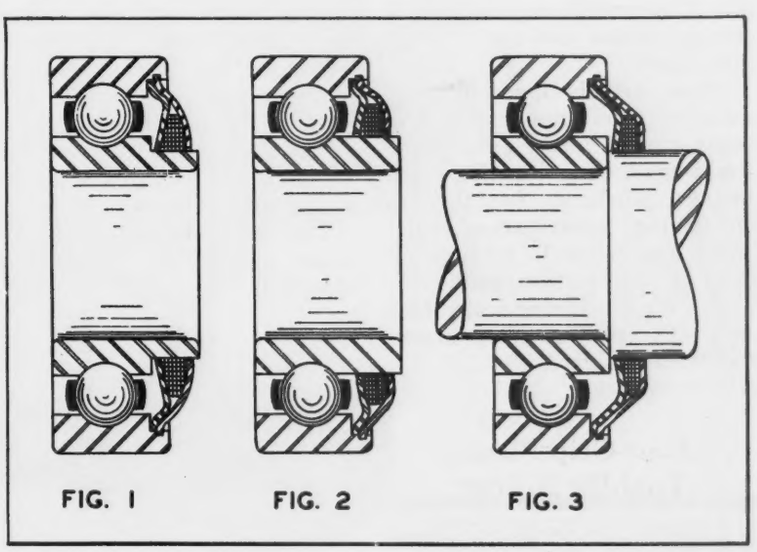
Metal of any thickness from 1/4 to 8 inches can be cut. Steel 1 inch thick can be cut at the rate of 12 inches per minute. Smooth cuts with sharp edges are made with the equipment, so that only 1/16 inch of stock need be allowed for machining when accuracy is essential.

Circles from 2 to 18 inches in diameter can be cut at any point by the use of a circle-cutting device. An aluminum table is supplied for tracing purposes and a special ply-wood table for use with wood or metal templets. Machines can be supplied up to 18 feet long by 5 feet wide.

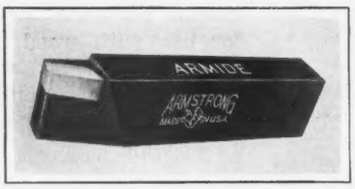
Oil Retainer for Ball Bearings

A patent for an oil retainer or seal for ball bearings, which is composed of two circular plates wedged together into a groove in the outer ring of the bearing, was recently granted to George O. Hodge, Plainville, Conn., and assigned to Standard Steel & Bearings, Inc., also of Plainville. Contained between the two circular plates of the retainer is a wiper or ring of felt that makes contact with the inner ring of the bearing, as shown in Figs. 1 and 2, or with the shaft, as illustrated in Fig. 3. The felt wiper forms an oil-stop that retains the lubricant within the bearing.

The circular plates are so constructed and assembled that a constant pressure is exerted against the felt ring. In this way, the felt ring is kept pressed against the inner ring or shaft, thus improving the sealing contact and taking up wear.



Ball-bearing Oil Retainers Brought out by Standard Steel & Bearings, Inc.



Cutter Bit Tipped with Armide

Armide Cutters

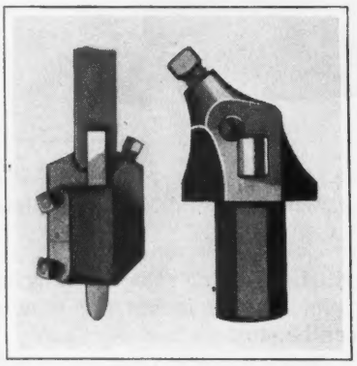
Cutter bits tipped with a carbide cutting metal known as "Armide" are being placed on the market by the Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill., for general use in the tool-holders made by this concern. Armide is a carbide alloy instead of a cemented substance. It has a hardness of from 88.5 to 90.5 on the Rockwell no-load C-scale, and a tensile strength of 250,000 pounds per square inch. One of the particular advantages of this metal is its toughness, which is such as to enable it to withstand shock, impact, or internal strain to an unusual degree.

The thermal conductivity of Armide is so low that the tip will remain cool and securely brazed to the bit, even though the chips are red hot. It is claimed that the cutting edge will not become grooved because the tip remains cool and because it will not alloy with iron and steel. It is also stated that chips will not become welded to the cutting edge, so that it is possible to use stronger cutting angles and higher running speeds.

These Armide-tipped bits are made in two types and in five ready-ground forms as follows: Right-hand, for turning and facing; left-hand, for turning and facing; square nose; round nose; and pointed, for cutting threads. The cutters can be employed for machining scaled cast iron, the toughest alloy steels, hardened steel, etc.

Four-Grip Planer Tool-Bit Holder

A planer tool-holder designed to facilitate the taking of top and side cuts in rapid succession on work has been added to the line manufactured by the Four-Grip Tool Co., 107 E. 17th St., Paterson, N. J. This tool-holder consists of two parts. The first is a shank which is clamped permanently to the rail-head and which has an octagonal socket. The second part is a head for holding the tool bit. This head has an octagonal stem to fit the socket in the shank. A plan view of the assembled unit is



Tool-holder Consisting of Shank and Separate Tool-bit Head

shown at the left in the illustration, and a front view of the bit-holder head at the right.

With the shank held on the planer rail-head, the octagonal fit of the socket and stem enables the tool bit to be held vertically for top surface planing and then quickly shifted for taking side or dovetail cuts. This is done by unclamping a set-screw, pulling the tool-bit head forward to withdraw the stem from the socket, turning the tool-bit head to the right or left a distance of one or two of the octagonal flats as required, replacing it in the socket, and reclamping it.

The tool bit is held in the holder by the Four-Grip method described in March, 1932, MACHINERY, page 553. The holder is made in two sizes for bits 5/8 and 3/4 inch square.

Double-End and Hollow-Ground End-Mills

End-mills with two cutting ends, as shown in Fig. 2, are made by the Weldon Tool Co., 1426 W. 3rd St., Cleveland, Ohio. With this design, fewer delays occur in regrinding, since the second end can be quickly brought into use. Easy reversal of the mill has been made possible by providing a parallel shank.

For milling machine jobs where unusually high feeds and speeds must be combined with clean cutting and freedom from chatter, the same concern has brought out a line of end-mills with hollow-ground lips, as illustrated in Fig. 1. It is claimed that the cutting edges of these end-mills retain their sharpness for a long period of time without

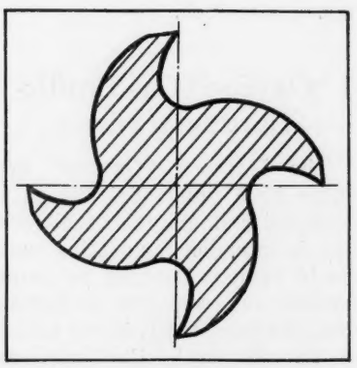


Fig. 1. Cross-section of "Wel-Don" Hollow-ground End-mill

regrinding, and that, since the hook of the hollow-ground lips curls up and ejects the chips efficiently, a clean finish and fast removal of metal are obtainable.

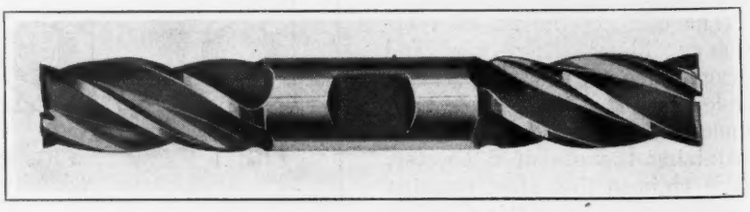


Fig. 2. "Wel-Don" End-mill of Double-end Construction

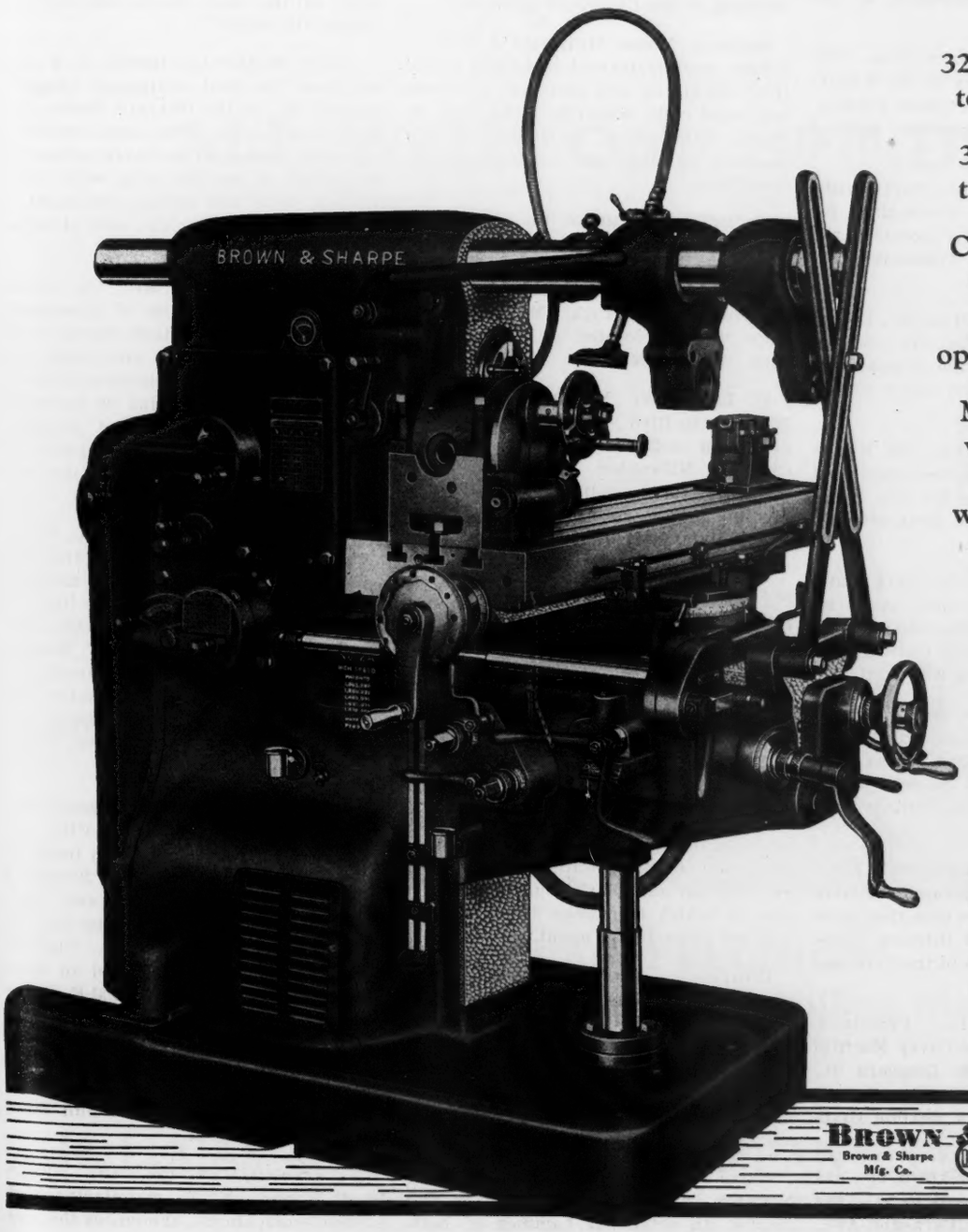
NEW HIGH SPEED

BROWN & SHARPE MILLING MACHINES
2A and 3A UNIVERSAL - - - 2B and 3B PLAIN

——to take full advantage of correct speeds for small end mills and new cutting alloys such as tungsten carbide

——to reduce setting-up time through convenience of complete front and rear controls

——to reduce time between cuts through power fast travel in all directions available from front or rear



32 Spindle Speeds to 1300 R.P.M.

32 Table Feeds to 62" per min.

Complete Table Control from front or rear operating position

Motor Driven, with electrical controls and wiring enclosed

Ask our representative to tell you about these modern cost cutting machines, or send for a circular.

BROWN & SHARPE
Brown & Sharpe Mfg. Co. — Providence R. I., U. S. A.

News of the Industry

HANS RENOLD, INC., has removed its offices from New York City, to 360 Furman St., Brooklyn, N. Y.

U. S. WELDING CO., INC., announces its removal to larger quarters at 108 Wallabout St., Brooklyn, N. Y.

BENJ. E. JARVIS, INC., maker of patterns and special machinery, has removed to 74-80 Malvern St., Newark, N. J.

TWIN DISC CLUTCH CO., Racine, Wis., announces that notwithstanding the business conditions in 1931, the company's customer list increased 31 per cent.

WILKINSON MACHINE SHOP, Plant City, Fla., has been started by C. W. Wilkinson to engage in oxy-acetylene welding, general repairing, and precision work of all kinds.

PRECISION CASTINGS CO., Fayetteville, N. Y., manufacturer of die-castings for many years, has recently acquired the FRANKLIN DIE CASTING CORPORATION of Syracuse, N. Y.

WELLS TOOL CO., 106 Hope St., Greenfield, Mass., announces that the company has brought out a new line of screw-cutting tools, including dies, screw plates, die-stocks, and taps.

CADILLAC MACHINERY CO., 528 Fisher Bldg., Detroit, Mich., has been appointed exclusive representative for the Rockford Drilling Machine Co., Rockford, Ill., in the Detroit territory.

HORSBURGH & SCOTT CO., 5114 Hamilton Ave., Cleveland, Ohio, manufacturer of gears and speed reducers, announces the opening of a Chicago district sales office at 844 Rush St., Chicago.

B-B NUT CO., Eighth and Columbia Ave., Philadelphia, Pa., has acquired the sole licenses for the United States, Canada, and Mexico, of all patents of the Safety Nut Corporation, Philadelphia, Pa.

MANUFACTURERS' CONSULTING ENGINEERS, Syracuse, N. Y., have moved from the McCarthy Building, where they have been located for the last thirteen years, to more modern quarters in the Syracuse Building.

GEARS & FORGINGS, INC., Cleveland, Ohio, have appointed the Carey Machinery & Supply Co., 119 E. Lombard St., Baltimore, Md., distributor for G & F speed reducers and Falk flexible couplings.

BARBER-COLMAN CO., Rockford, Ill., has recently made arrangements to have the Brown Tool Co., 10465 Carnegie Ave., Cleveland, Ohio, distribute Barber-Colman temperature control equipment in northern Ohio.

BREUER ELECTRIC MFG. CO., 852 Blackhawk St., Chicago, Ill., has placed on the market a new portable electric blower, known as the Tornado Model 4, for blowing dust out of motors and machinery parts, bins, etc.

CHICAGO FLEXIBLE SHAFT CO., Roosevelt Road and Central Ave., Chicago, Ill., announces that A. E. Goldie, 561 E. 108th St., Cleveland, Ohio, has been appointed representative for Stewart industrial furnaces in the Cleveland territory.

SHELDON, MORSE, HUTCHINS & EASTON, a firm recently formed to handle industrial marketing and economic problems connected with scientific industrial research, have moved their offices to the Graybar Building, 420 Lexington Ave., New York.

GEOMETRIC STAMPING CO., Cleveland, Ohio, announces the appointment of R. F. Mosedale as the company's representative in northwestern Pennsylvania and western New York. Mr. Mosedale's office will be located at 233 Jackson Bldg., Buffalo, N. Y.

E. L. ESSLEY MACHINERY CO., 551 Washington Blvd., Chicago, Ill., has been appointed exclusive selling agent in the Chicago, Milwaukee, and Minneapolis territories for the full line of high-speed riveting hammers made by the High Speed Hammer Co., of Rochester, N. Y.

FOOTE BROS. GEAR & MACHINE CO., 215 N. Curtis St., Chicago, Ill., elected the following officers at the last annual meeting: President, F. H. Fowler; vice-presidents, W. A. Barr, F. A. Emmons, and H. H Bates; secretary and treasurer, A. L. Gray; and assistant treasurer, J. R. Fagan.

INDUSTRIAL CONSTRUCTION CORPORATION, LTD., 5125 Santa Fe Ave., Los Angeles, Cal., has taken over the complete line of the Shepard Niles Crane & Hoist Corporation for southern California, Arizona, and Lincoln and Clark counties in Nevada, in which territories this company will act as exclusive agent.

HOMESTEAD VALVE MFG. CO., INC., Coraopolis, Pa., has appointed the Shaw-Palmer-Bakewell Co., 409 E. 3rd St., Los Angeles, Calif., as sales representative for the company's "Hypressure Jenny" in the Los Angeles district. This device is intended for the cleaning of machinery, equipment, and buildings.

DAVID MAYDOLE TOOL CORPORATION, Norwich, N. Y., has introduced on the market an octagonal hammer of high quality known by the trade name "Octole." The new hammer is characterized by a polished head and neck, round bell face, double tapered adz-eye, and the well-known Maydole wedging.

R. WIRTH has been appointed successor to A. H. Tischer as district representative in the Indiana territory for the sale of IXL gears and speed reducers, made by the Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill. Mr. Wirth's headquarters are at 617 Merchants Bank Bldg., Indianapolis, Ind.

FARREL-BIRMINGHAM CO., INC., Ansonia, Conn., manufacturer of chilled rolls and heavy machinery, announces that at the last meeting of the board of directors, Franklin Farrel, Jr., was re-elected chairman of the board and Nelson W. Pickering was re-elected president. All the other officers and directors remain the same.

LUMEN BEARING CO., Buffalo, N. Y., has purchased the plant, equipment, supplies, patents, etc., of the BUFFALO BRONZE DIE CAST CORPORATION. The plant comprises a foundry with a large amount of special equipment, a machine shop with many machine tools and special equipment, a well equipped core room, and cleaning and snagging rooms.

COLUMBIA ELECTRIC MFG. CO., Cleveland, Ohio, manufacturer of generators, motor-generators, and tank rheostats for the plating industries, announces the formation of an electro-chemical division to handle a complete line of polishing and plating equipment and supplies. F. G. Cyrex will act in the capacity of manager and chief engineer of the new division.

BURKE ELECTRIC CO., Erie, Pa., manufacturer of motors, generators, and electric welders, announces that the distribution of the company's complete lines in the Chicago district is now being handled by Albert J. Walz, 205 W. Wacker Drive, Chicago, Ill. P. J. Burrill and J. L. Vergillio have been appointed general distributors for northern Ohio, and are located at 942 Prospect Ave., Cleveland, Ohio.

ST. JOHN X-RAY SERVICE CORPORATION, 505 Fifth Ave., New York City, announces that the company has installed the first X-ray machine ever furnished to a shipyard for commercial use. This equipment has been installed by the Sun Shipbuilding & Drydock Co., Chester, Pa. It is primarily designed to meet the requirements of the A.S.M.E. boiler code for welded pressure vessels, but can also be used for examining any other welded construction, as well as castings and forgings. Outside work will also be handled by the Sun Shipbuilding Laboratory.

WATSON-STILLMAN CO., 107 Aldene Road, Roselle, N. J., manufacturer of hydraulic machinery, announces that the

SPEED

1200 R.P.M. down to 13½ R.P.M.

For a ¼" DRILL at a cutting speed of approximately 80 ft. per minute, with feeds available as fine as .002" per revolution.

For a 1" TUNGSTEN CARBIDE END MILL with a cutting speed of more than 300 FT. PER MINUTE on cast iron.

For a 2½" high speed steel END MILL with No. 5 Morse Taper Shank, at nearly 800 FT. PER MINUTE on ALUMINUM with a FEED of over 80 INCHES PER MINUTE.

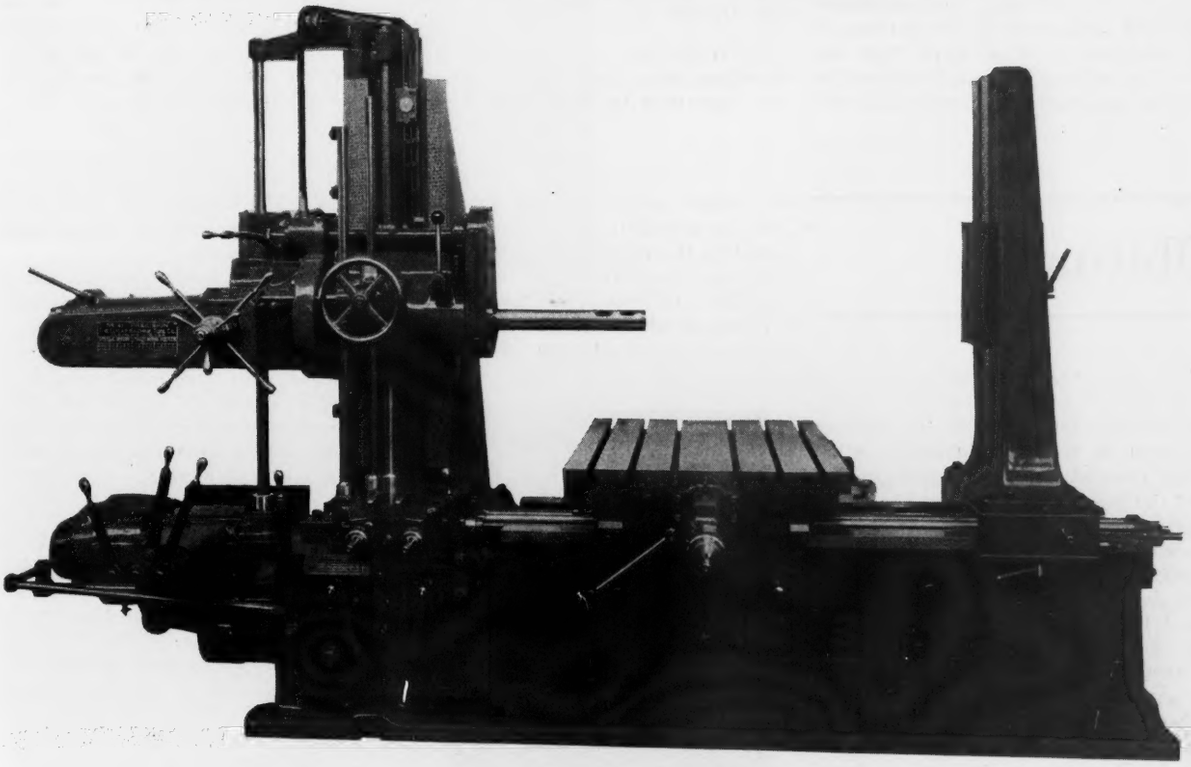
For FACING FLANGES as large as 17" DIAMETER at a cutting speed of 60 ft. per minute with a Star Feed Facing Head.

AMPLE POWER and RIGIDITY

For HEAVY CUTS with a 12" FACE MILLING CUTTER and

For BORING LARGE HOLES and CYLINDERS up to 12" DIAMETER with multiple tool boring heads.

ALL WITH ONE SPINDLE



No. 41 LUCAS "PRECISION"
Horizontal Boring, Drilling and Milling Machine
WITH HI-SPEED DRIVE

designed and made by

THE LUCAS MACHINE TOOL COMPANY, Cleveland, Ohio

FOREIGN AGENTS: Allied Machinery Co., Barcelona, Zurich. Andrews & George Co., Tokyo. Catmur Machine Tool Corp., Ltd., London, Eng. M. Kocian & G. Nedela, Prague. V. Lowener, Copenhagen, Oslo, Stockholm. Emanuele Mascherpa, Milan, Italy. R. S. Stokvis & Zonen, Rotterdam, Paris.

president of the company, E. A. Stillman, who recently returned from a business trip to England, Germany, and France, obtained the American rights, while he was in England, to the Henley straight-through lead-sheathing presses, and also made an agreement with Davy Brothers, of Sheffield, covering the manufacture of Watson-Stillman equipment in England and the manufacture of certain Davy Brothers' hydraulic equipment in the United States.

LEON V. QUIGLEY has established his own business as counsel on public relations at 730 Fifth Ave., New York City. Public relation work Mr. Quigley defines as sales promotional work along the lines of information and education, advice on advertising policies, the preparation of house organs, personnel instruction booklets, technical bulletins, lectures, and the preparation for newspapers and magazines of industrial news in a form timely, authentic, and acceptable for use in the editorial columns. Mr. Quigley is a graduate of the Worcester Polytechnic Institute with the degrees of B.S. and M.S.

NORTHERN ENGINEERING WORKS, 210 Chene St., Detroit, Mich., has established a welding department as the outcome of the extensive welding work that has been done by the company in connection with the manufacture of cranes and electric hoists. The new department is equipped to design and produce a wide variety of welded steel products for commercial use, including steel frames, bases, gear housings, casings, jigs, fixtures, fabricated structures, miscellaneous standard and special machinery parts. It will also have facilities for cutting intricate shapes. The services of an experienced engineering, designing, and lay-out department will also be available in connection with this work.

DIAMOND CHAIN & MFG. CO., Indianapolis, Ind., manufacturer of single- and multiple-strand roller chains, sprockets, and flexible couplings, has appointed new West Coast representatives as follows: The Puget Sound Machinery Depot will represent the company in Oregon and Washington, with stocks carried at Klamath Falls and Portland, Ore., and Hoquiam and Seattle, Wash. Joseph D. Christian Engineers, of San Francisco, Cal., have been made engineering representatives, and the Horsford Bros. Co., of the same city, industrial distributors for northern California. In the Los Angeles territory, the Goddard Jackson Co. is now representative. Complete stocks will also be carried in San Francisco and Los Angeles.

STANDARD OIL CO. (Indiana), 910 S. Michigan Ave., Chicago, Ill., announces that beginning in April, it will publish each month a technical monograph on the lubrication of some type of equipment. The company states that it has found that many plant men have expressed the desire to have specific authoritative information on the proper lubrication of various types of machinery. The plan is to cover the whole line of the more important industrial equipment, making each lubrication discussion simple, brief, and informative. No recommendations for any particular brands of lubricants will be made. Requests for these monographs should be addressed to the Technical Division, 910 S. Michigan Ave., Chicago.

KLING BROTHERS ENGINEERING WORKS, Chicago, Ill., announce that they have purchased from Joseph T. Ryerson & Son, Inc., Chicago, the complete line of Ryerson high-speed friction saws and accessory equipment. The purchase includes manufacturing and selling rights, drawings, patterns, and stock on hand. The Kling plant has manufactured these machines for Joseph T. Ryerson & Son, Inc., for many years. The engineering personnel responsible for the development of the machines has also been transferred to the Kling staff. The general distribution of the friction saw line, including sales engineering and other sales activities, will be handled by the Bryant Machinery & Engineering Co., 400 W. Madison St., Chicago, Ill.

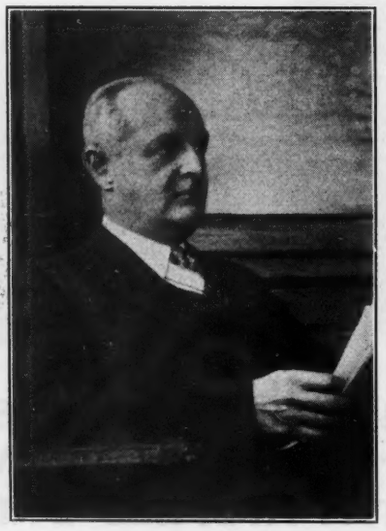
Obituaries

C. C. BRADLEY, JR., president of C. C. Bradley & Son, Inc., Syracuse, N. Y., died suddenly on March 8. Mr. Bradley was born in Syracuse in 1873. After having completed his education, he entered the business founded by his father in Syracuse. When the company was incorporated in 1894, Mr. Bradley was made vice-president, and in 1896 he became secretary and treasurer. He succeeded his father as president in 1916.

In addition to his business interests, Mr. Bradley gave a great deal of time and effort to civic activities. He was Commissioner of Public Safety of Syracuse from 1927 to 1929. He was widely known and highly regarded throughout the machinery field, and his genial personality won him many warm friends.

HUGH REGINALD CORSE, sales manager of the Lumen Bearing Co., Buffalo, N. Y., died suddenly on February 20 of heart disease, at his home in Buffalo. He was apparently in good health until the day of his death.

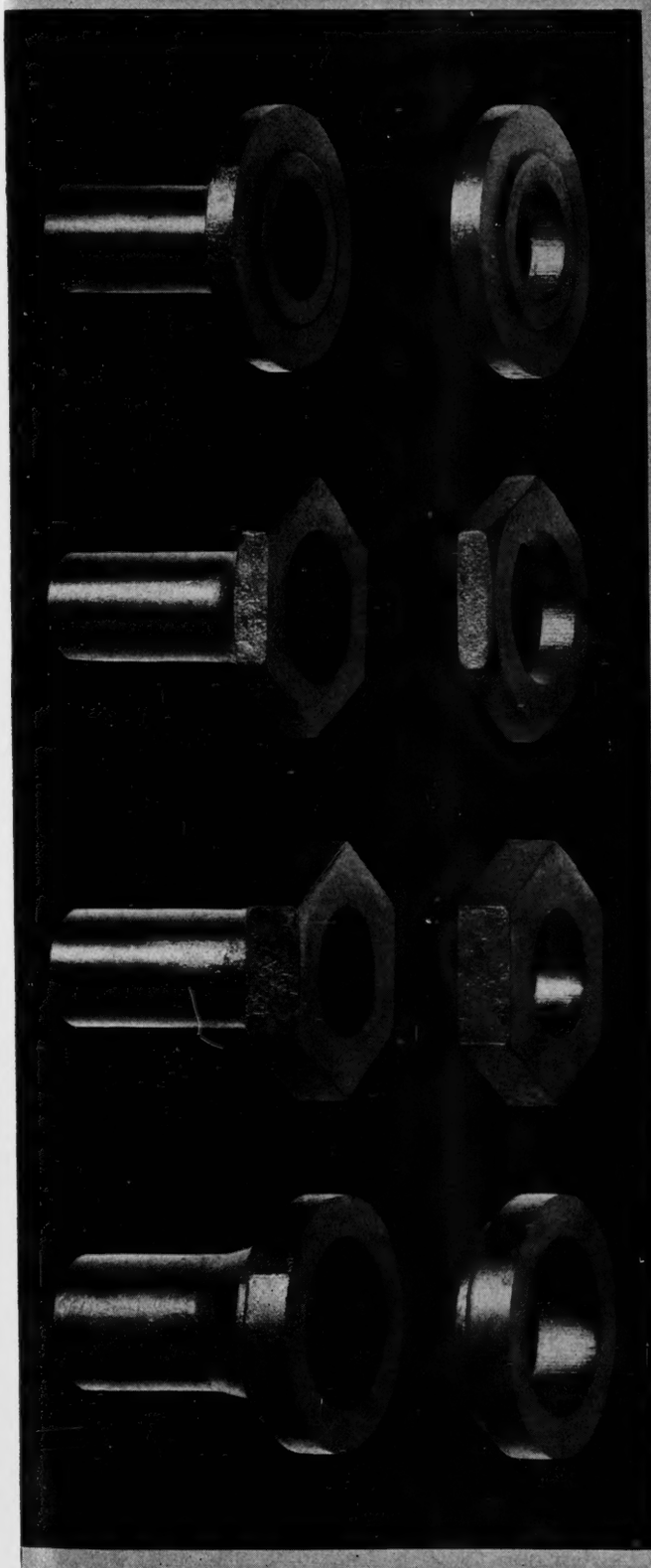
Mr. Corse was born at Malden, Mass., on February 29, 1880, and was educated in the Massachusetts public schools. He was first employed in the manufacture of rubber goods in Connecticut. In 1905, he moved to Detroit, where he engaged in the radiator business, automobile manufacturing, and selling mill supplies. In 1910, he joined the sales department of the Lumen Bearing Co., and was connected with this company until the time of his death, with the exception of the six years between 1914 and 1920, when he was with the Titanium Bronze Co. of Niagara Falls, N. Y. His special work was promoting the sales and use of high-grade brass and bronze alloys.



Hugh Reginald Corse

Mr. Corse was active in automotive circles, having been a member of the Society of Automotive Engineers and an active worker on the S A E committee dealing with non-ferrous alloys. He was also a member of the Buffalo Engineering Society and other technical associations. He is survived by his widow, a son, and a daughter.

JOHN T. CLANCY, an executive of the Worthington Pump & Machinery Corporation, Harrison, N. J., died suddenly of a heart attack, March 9, while lecturing at the Engineers' Club, New York City, before a meeting of the American Society of Mechanical Engineers. Mr. Clancy was born in New Brunswick, N. J., in 1890. After attending the New Brunswick schools, he studied at Betts Academy, Stamford, Conn., and later at Bowdoin College, where he was graduated in 1913, and at Catholic University. He became an instructor in mathematics and chemistry at the Army & Navy School, Washington, D. C., and in 1917 he entered the Army, seeing overseas service as Captain of Field Artillery with the A. E. F. In 1919, he joined the Worthington Pump and Machinery Corporation, and in 1923 became assistant manager of oil and gas engine sales, the position he held until his death.



HEXAGONAL AND RING NUT FORGINGS UPSET AND PUNCHED WITHOUT WASTE

THIN, large diameter special nut forgings made on *AJAX Forging Machines* by the upset and punch-off method result in an improved product at a decreased cost.

Such pieces are upset on the end of round bar stock and punched-off in a simple two operation die. The metal displaced by the punch remains on the end of the bar and goes into the next forging, limiting waste to a short tong hold at the end of each bar.

Forging productions are high and forging costs are consequently low. The forgings are strong, clean and uniform, requiring but little machining to finish.

These hexagonal and ring nuts are but typical of a class of punched-off forgings produced on *AJAX Upsetting Forging Machines* with decreased cost and improved quality.

THE AJAX MANUFACTURING CO.

EUCLID BRANCH P. O., CLEVELAND, O.

Chicago Office: 621 Marquette Bldg.

AJAX

Men in the Industry

A. E. BALLIN, formerly president of McIntosh and Seymour Corporation, Auburn, N. Y., has been made vice-president in charge of sales and engineering of the Nordberg Mfg. Co., Milwaukee, Wis.

H. E. CASLER, production manager of the Westcott Chuck Co., Oneida, N. Y., for the last five years, has been made factory manager of the Converse-Mason Corporation, toy manufacturers, of Winchendon, Mass.

C. H. CROCKER, comptroller of the Worthington Pump & Machinery Corporation, Harrison, N. J., has been elected vice-president of the American Management Association, in charge of a newly organized unit called the Comptrollers' Division.

WILLIAM DAVID COOLIDGE, associate director of the research laboratory of the General Electric Co., Schenectady, N. Y., received the Washington Award for 1932 on February 24, "in recognition of devoted, unselfish, and preeminent service in advancing human progress."

H. R. AUDET has just been appointed Michigan manager of the Greenfield Tap & Die Corporation, Greenfield, Mass., and will make his headquarters at Detroit. Mr. Audet was formerly connected with the General Motors Export Co., of which he has been division manager for the last six years.

GUY H. BILLINGS has been appointed assistant general manager of the Four Wheel Drive Auto Co., Clintonville, Wis., manufacturer of automobile trucks. Mr. Billings has been connected with the company for nineteen years, having

Guy H. Billings

served for the last seventeen years as purchasing agent. He will retain his position as purchasing agent.

DR. IRVING LANGMUIR, associate director of the research laboratory of the General Electric Co., Schenectady, N. Y., was presented on February 29 in New York with a gold medal and the sum of $10,000, awarded annually by *Popular Science Monthly* for notable scientific achievement by an American.

DR. ANSON MARSTON, dean of engineering at Iowa State College, Ames, Iowa, will retire from his administrative duties June 30. He will be succeeded by Professor T. R. Agg, now assistant dean of engineering. Dean Marston has been a member of the faculty of the College of Engineering of the Iowa State College for forty years, and has been dean for twenty-eight years. The engineering college had an enrollment of 200 when he came; it now has an enrollment of 1900.

HAROLD B. RESSLER, vice-president at Chicago of Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill, has been made manager of the St. Louis plant of the company. Mr. Ressler was previously St. Louis plant manager for fifteen years, and will now be in direct contact with the St. Louis organization, making regular visits to the plant in the St. Louis territory. In Mr. Ressler's absence, R. B. WILSON, manager of sales of the Ryerson St. Louis plant, will be the senior resident executive.

WILLIAM H. SCHEER has been transferred from the Dayton territory of the Ex-Cell-O Aircraft & Tool Corporation, 1200 Oakman Blvd., Detroit, Mich., to the Chicago office of the company, from which he will cover northern and western Indiana and the southwestern part of Michigan. H. E. HENRY, of the Cleveland office, has been given charge of that territory, and will be located at 1240 Bender Ave., East Cleveland, Ohio. FRANK STROTHER, formerly in charge of the Cleveland territory, has been transferred to the home office in Detroit.

ALBERT E. GROVER has succeeded CHARLES E. MITCHELL as cost director for the Gray Iron Institute, Inc., Cleveland, Ohio. Mr. Grover will have charge of the cost work in the central and western area. He has been cost consultant for the National Machine Tool Builders' Association for nearly four years, and in his twenty-six years of experience has been identified with a number of prominent companies as cost executive. He has also written a number of articles on cost accounting, and has addressed cost groups throughout the country.

Coming Events

APRIL 11-16—Ninth annual Oil Burner Show to be held in Mechanics Hall, Boston, Mass., under the auspices of the American Oil Burner Association, 342 Madison Ave., New York City.

APRIL 20—Thirty-fourth annual convention of the National Metal Trades Association to be held at the Hotel Commodore, New York City. J. E. Nyhan, national secretary, Peoples Gas Bldg., Chicago, Ill.

APRIL 27-29—Annual meeting of the American Welding Society at the Engineering Societies' Building, 29 W. 39th St., New York. William T. Spraragen, secretary, 29 W. 39th St., New York City.

MAY 3-5—Annual convention of the American Foundrymen's Association to be held at the Hotel Statler, Detroit, Mich. Executive secretary, 222 W. Adams St., Chicago, Ill.

MAY 4-5—Management, Maintenance and Materials Handling Meeting of the American Society of Mechanical Engineers, at the Hotel Statler, Detroit, Mich. This meeting was formerly planned to be held in Philadelphia, but the Philadelphia meeting has been cancelled.

MAY 12-13—Sixteenth annual meeting of the American Gear Manufacturers' Association to be held at the Hotel Statler, Cleveland, Ohio. The Executive Committee will meet at the same place, May 11. T. W. Owen, secretary, 3608 Euclid Ave., Cleveland, Ohio.

JUNE 20-24—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. C. L. Warwick, secretary, 1315 Spruce St., Philadelphia, Pa.

JUNE 27-30—Semi-annual meeting of the American Society of Mechanical Engineers, jointly with the Canadian Institute of Engineers, at Bigwin Hotel, Lake of Bays, Highlands of Ontario, Canada. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

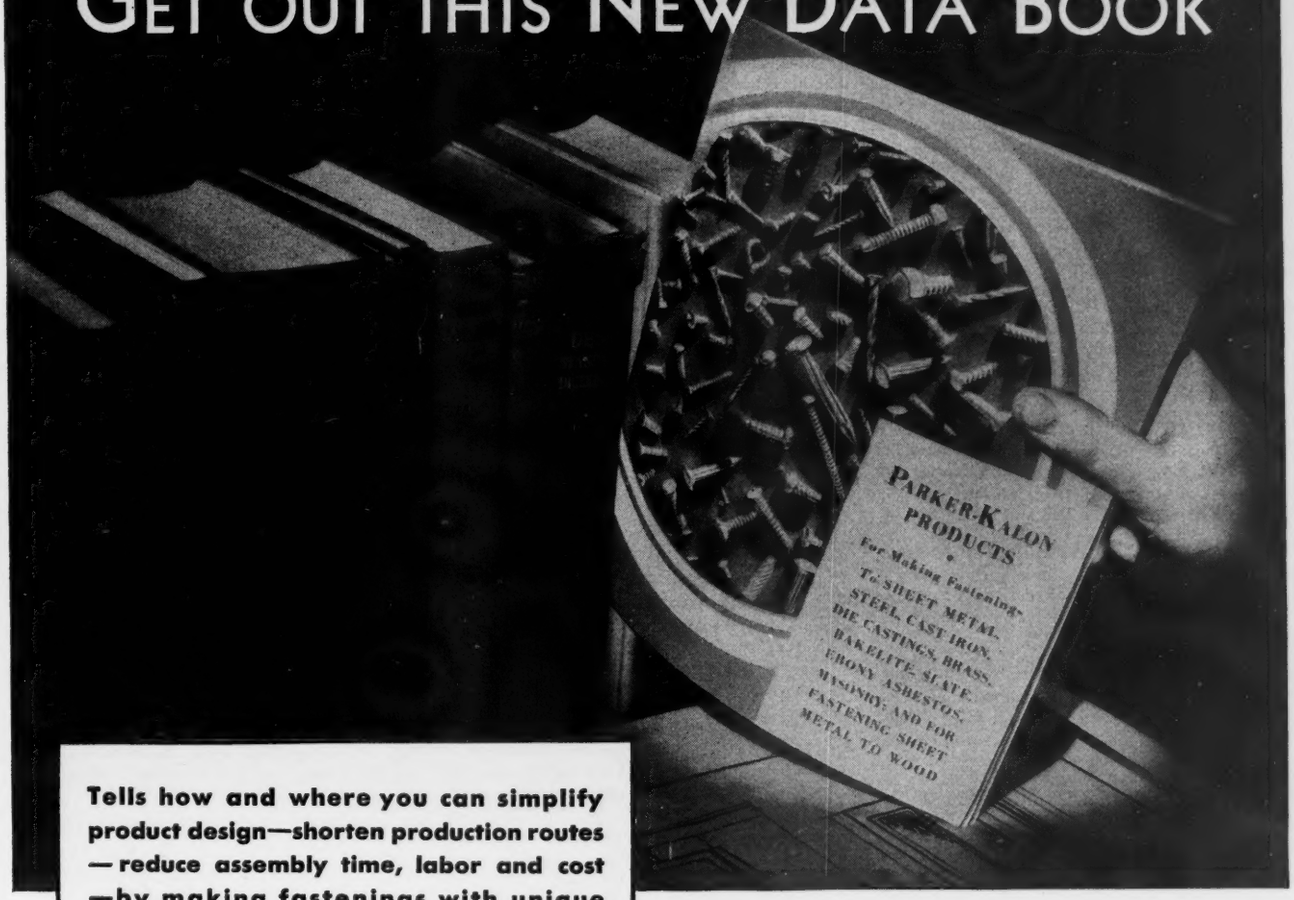
SEPTEMBER 10-17—Machine Tool Exposition of the National Machine Tool Builders' Association, at Cleveland, Ohio. Boyd Fisher, general manager, 617 Vine St., Cincinnati, Ohio.

OCTOBER 3-7—National Metal Congress, Buffalo, N. Y., sponsored by the American Society for Steel Treating, 7016 Euclid Ave., Cleveland, Ohio, with the cooperation of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Welding Society, and the Wire Association.

OCTOBER 3-8—Fourteenth annual National Metal Exposition to be held in the 174th Regiment Armory, Buffalo, N. Y. W. H. Eisenman, secretary, American Society for Steel Treating, 7016 Euclid Ave., Cleveland, Ohio.

When you're considering fastenings

GET OUT THIS NEW DATA BOOK



Tells how and where you can simplify product design—shorten production routes—reduce assembly time, labor and cost—by making fastenings with unique Screws and Nails made by Parker-Kalon.

When you are developing a new product, consult the Parker-Kalon Catalog Data Book. You may find that one of the modern Parker-Kalon fastening devices will help you simplify design and construction. They have solved fastening problems for thousands of manufacturers.

Get out this book, also, when you are looking for ways to reduce production costs. Use it to check up on assembly methods. In most cases you will find that Parker-Kalon Screws and Nails offer a simpler, speedier, cheaper and more secure means of making fastenings.

Get this new Book. Keep it handy for reference when you're considering means of assembly. It contains complete information — all you want to know about the fastening devices which are helping leaders in the metal working industry to make better products at lower costs — it is free — just fill in and mail the coupon below.

PARKER-KALON *Hardened* Self-tapping Screws

PAT. IN U. S. AND FOREIGN COUNTRIES

Parker-Kalon Corporation, Dept. F, 200 Varick Street, New York, N. Y.

Send a free copy of your new Catalog-Data Book to:—Name_____

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New Catalogues and Circulars

WELDING MACHINES. Thomson-Gibb Electric Welding Co., Bay City, Mich. Circular illustrating the use of Thomson-Gibb welding machines in brake-shoe manufacture.

TOOL-HOLDERS. Four-Grip Tool Co., 107 E. 17th St., Paterson, N. J. Circular illustrating and describing the four-grip rigid tool-bit holder for standard commercial bits.

ELECTRIC FANS. Century Electric Co., 1806 Pine St., St. Louis, Mo. Bulletin 42, descriptive of the Century line of alternating- and direct-current fans for industrial use.

STAINLESS STEEL. Lebanon Steel Foundry, Lebanon, Pa. Circular describing the properties and application of Circle "L" stainless steel alloys for corrosion- and heat-resistance.

ELECTRIC MOTORS. Bodine Electric Co., Oakley Blvd. and Ohio St., Chicago, Ill. Bulletin 1013, illustrating and describing electric governor controlled constant-speed universal motors.

MAGNETIC SEPARATORS. Magnetic Mfg. Co., Milwaukee, Wis. Bulletin 20, describing in detail the Stearns Type Q magnetic separators for separating free iron from finely ground material.

MOTORS. Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio. Bulletin 211, illustrating various special designs of motors and giving dimensions and horsepower for the different types.

PRESSURE GAGES. Bristol Co., Waterbury, Conn. Catalogue 1011, supplementary to No. 1010, describing the construction and principal features of the Bristol direct-reading, recording, absolute pressure gage.

SHEET-METAL WORKING MACHINES. Niagara Machine & Tool Works, Buffalo, N. Y. Bulletin 77, illustrating and describing the Niagara line of slip roll forming machines of the hand- and power-operated types.

CLUTCHES. Morse Chain Co., Ithaca, N. Y. Bulletin C-66, illustrating and describing the Morse "Pullmore" clutch. The circular gives horsepower ratings and dimensions of the various sizes, and shows typical applications.

BELT CONVEYORS. Diamond Rubber Co., Inc., Akron, Ohio. Booklet entitled "How Shall We Handle It?," containing a large number of photographs illustrating applications of the belt conveyor in twenty-seven different industries.

WIRE ROPE. Hazard Wire Rope Co., Wilkes-Barre, Pa. Booklet entitled "Twelve Reasons Why You Save Money with Lay-set Preformed Wire Rope," containing a great deal of information of interest to wire rope users.

X-RAY EQUIPMENT. Claud S. Gordon Co., 708 W. Madison St., Chicago, Ill. Circular entitled "Secrets of Metal as Revealed in Welds by Means of the X-Ray," describing results that have been obtained in radiographing welds.

SPEED REDUCERS. Janette Mfg. Co., 556 W. Monroe St., Chicago, Ill. Circular illustrating and briefly describing the Janette motorized speed reducer, which is made in single- and double-reduction worm-gear types and single-reduction spur gear type.

ELECTRIC EQUIPMENT. Allen-Bradley Co., 1331 S. First St., Milwaukee, Wis. Loose-leaf circulars covering automatic starters, reverse switches, drum controllers, speed regulators, treadle-operated controllers, alternating-current contactors, and photo-electric relays.

MATERIAL-HANDLING EQUIPMENT. Cleveland Electric Tramrail Division of the Cleveland Crane & Engineering Co., Wickliffe, Ohio. Circular entitled "Buckets Must be Used," illustrating various applications of bucket-type containers for moving materials and product.

SPIRAL BEVEL GEARS. Gleason Works, 1000 University Ave., Rochester, N. Y. Leaflet on spiral bevel gears, containing information on method of cutting, advantages, strength, wear, efficiency, application, mounting, spiral angle, axial thrust loads, practical points in design, and cost.

OILLESS BEARINGS. Spadone Machine Co., Inc., 15 Park Row, New York City. Bulletin containing information on Metaline oilless bearings. Typical examples of the different types are illustrated; a table of standard dimensions is given; and suggestions for installing and ordering these bearings are included.

MOTORS. Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo. Bulletin 174, on squirrel-cage motors, describing the seven types of motors made by this concern and giving application tables, speed-torque curves, and complete construction details. The bulletin is published in loose-leaf form, so that it may be conveniently kept up to date.

ENGRAVING MACHINES. H. P. Preis Engraving Machine Co., 227 Fulton St., New York City. Circular illustrating and describing Deckel engraving machines. The various types of these machines are shown, and dimensions and other specifications are included. Typical applications and examples of work for which these machines are adapted are also illustrated.

ROLLER BEARINGS. Shafer Bearing Corporation, 6501 W. Grand Ave., Chicago, Ill. Bulletin 501, listing all sizes of Shafer radial-thrust single- and double-row roller bearings. The bearings are listed by bores, complete dimensions, tolerances, load ratings, list prices, and code words being included. A table of speed factors is given for figuring intermittent speeds.

INDUSTRIAL PUMPS. Domestic Engine & Pump Co., Shippensburg, Pa. Bulletins NI-31, RI-31, and SB-305, illustrating and describing, respectively, single-suction, single-stage centrifugal pumps; self-priming centrifugal pumps; and automatic-priming ball-bearing centrifugal pumps. A performance chart is given for each of these types of pumps, showing pump size, motor size, and speed.

FLEXIBLE COUPLINGS. Diamond Chain & Mfg. Co., Indianapolis, Ind. Catalogue 11, outlining the features of construction of the Diamond flexible coupling, and giving tables of dimensions, weights, horsepower transmitted, and other specifications for the different types and sizes. Data is also given on the selection and installation of these couplings. Various types of drives are shown with loads up to 700 horsepower.

BELTING. Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J. Engineering data book and catalogue of Condor V-belt. The book shows the range of the Condor line of V-belts, and gives information that will simplify the ordering of the correct sizes, as well as operating and designing data. Circular illustrating the construction of Condor V-belts and outlining their advantages. List prices are included.

NICKEL-ALLOY STEEL PRODUCTS. International Nickel Co., Inc., 67 Wall St., New York City. Buyers' Guide for 1932, which consists of a directory of manufacturers, fabricators, and distributors of nickel-alloy steel products. The directory is divided into five sections, as follows: Section I, structural grades, 1 to 5 per cent nickel steels; Section II, corrosion-resistant steels—chrome-nickel austenitic type; Section III, heat-resistant nickel-chrome-iron alloys; Section IV, special ferro-nickel alloys; and Section V, special services.

New Books and Publications

INTERNATIONAL MEASUREMENT UNITS —TENTATIVE AMERICAN STANDARDS 1932. 56 pages, 7¾ by 10½ inches. Published by the American Institute of Weights and Measures, 33 Rector St., New York City. Price, $1.50.

This compilation of data pertaining to fundamental measurement units and standards covers four types of standards as follows: (1) Legal standards adopted and approved by legislative bodies; (2) private standards set up by manufacturers and others for their own use; (3) units that were formerly used as part of a complete measurement system, but that now remain only as independent units, practically apart from the main system; (4) series units and series of sizes, the use of one term as a unit being impracticable without the use of all the terms of the series.

With this division for measuring units in mind, the publication takes up the subject of an international system of weights and measures. It reviews, sometimes unfavorably, the efforts of contemporary standardizing bodies and makes recommendations applicable to the mechanical, electrical, and chemical industries, suggesting methods of standardization procedure.

ECONOMICS OF TOOL ENGINEERING. By Alexander P. Gwiazdowski and Chester B. Lord. 203 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $2.50.

This book is designed primarily as a textbook for the engineering student who has previously had pattern, foundry, forge, and machine shop practice. In order to encourage original thinking and analyzing on the part of the student, the design of many of the auxiliaries used with jigs and fixtures has not been touched upon. The material is arranged in such a manner that the book may be used by the instructor in teaching jig and fixture design or tool engineering; by the toolmaker who desires to enter the designing field; or by the draftsman who lacks technical education. An idea of the contents will be obtained from the following list of chapter headings: The Tool Engineer in Modern Industry; Tooling Methods; Tooling Methods in Different Industries; Production of Machine Parts; Cutting Tools; Drilling Machines, Multiple-spindle Drill Heads, and Drill Jigs; Drill Jigs Made by the Welding Process; the Milling Process and Fixtures; Jig and Fixture Design as Practiced by the Automotive Industry; Design of Jigs and Fixtures; "Tooling Up" the Component Parts of a Bench Type Drill Press; Gages; and Jig-boring Methods.

MACHINERY for MAY

Featuring
The Cutting of Metals

Recording the Progress in Metal-Cutting Steels and Alloys

IT is less than four years ago that tungsten-carbide tools were first announced in the United States; and yet, in these four years, this new cutting alloy, along with other newly discovered tool materials, has completely changed the machining practice in a great many plants, especially in the electrical and automotive industries.

Wide publicity has been given in the technical press to the properties and performance of these new cutting materials, as well as to the improvements that have been made in the Stellite group of cutting metals and in the high-speed steels.

The shop executives in the quantity-production plants have followed these developments closely and have arrived at an accurate estimate of the value of the new tools for different purposes. To the average shop executive in plants building machinery of a varied character, and to the men in charge of the smaller shops, however, this development has proved more or less confusing, because they have not been able to demonstrate in their own shops and to their own satisfaction that the claims made for the new cutting alloys can be substantiated. Some shop executives are even likely to apologize to the casual visitor passing through their shops, because they are not using these new cutting alloys.

It, therefore, seems appropriate to review the present status of the materials used for cutting tools in American machine shop practice, and to attempt to evaluate these tool materials in order to establish, to the extent that this may be possible, their place in present-day practice.

It is obvious that no hard and fast rules can be laid down. No distinct line of demarcation can be drawn between the fields of usefulness of the different steels and alloys; but, in a general way, the experience of industry up to the present time may be indicated, and future possibilities may be pointed out.

An attempt has been made in the following articles to discuss the present-day cutting materials from an impartial point of view, and to clarify the question as to when and where a certain tool material can be used to best advantage.

The new carbide materials, the cobalt-chromium-tungsten alloys (Stellite), and the newer high-speed steels—so-called "super high-speed" steels—have effected notable economies when used under suitable conditions for cutting the materials for which they are adapted. Many materials heretofore considered unmachineable can now be machined with these new tools. They have also made possible cutting speeds and tool life far beyond the expectations of the engineer five years ago.

On the other hand, there are many instances where the well-known standard 18-4-1 (18 per cent tungsten, 4 per cent chromium, 1 per cent vanadium) grade of high-speed steel appears to be best adapted for the work to be done. In the light of our present knowledge, it is generally possible to determine which cutting-tool material is most suitable for a given purpose.

Briefly, the cemented carbides have proved of especial advantage on non-metallic and non-ferrous materials, and on cast iron; but recently, steel-cutting carbide tools have been introduced and successfully applied in many instances.

The group of cutting alloys known as Stellite is used to best advantage for machining cast iron, malleable iron and semi-steel, as well as some non-ferrous materials; however, Stellite has also been widely used in cutting steel, and the new J-Metal is applicable to the cutting of all the metals mentioned.

The cobalt high-speed steels have been found particularly useful in machining high-manganese steel that formerly could not be machined with any cutting tool, but had to be ground with abrasive wheels.

For most operations in the average shop, high-speed steel is still generally used; and while it is gradually being replaced for many operations by the new cutting tools, it fills an important place in industry. For such tools as drills, the majority of milling cutters, reamers, and hobs, high-speed steel is still the material of the widest application.

Carbon tool steel is also widely used. Millions of drills, as well as taps and many other small cutting tools, are manufactured annually from this material.

The articles that follow will elaborate upon this brief summary. They were prepared by men exceptionally well fitted by training and experience to record the practical application of the various cutting materials in present-day machine shop practice.

The Present Status of Cemented-Carbide Tools

A PROGRESS RECORD IN THE ART OF CUTTING METAL

A Review of the Remarkable Strides Made in the Application of the New Cemented-Carbide Tools to Modern Shop Practice

A PROGRESS RECORD IN THE ART OF CUTTING METAL

By MALCOLM F. JUDKINS, Engineer
Firth-Sterling Steel Co., McKeesport, Pa.

CEMENTED tungsten carbide consists essentially of minute grains of tungsten carbide embedded in a cementing matrix which is a solid solution of tungsten, carbon, and cobalt. The fact that tungsten metal can be carburized to produce a metallic substance possessing extreme hardness has long been known. Before this material could be made of practical use in cutting metals, however, it was necessary to develop a suitable method of strengthening the hard particles and holding them tightly together.

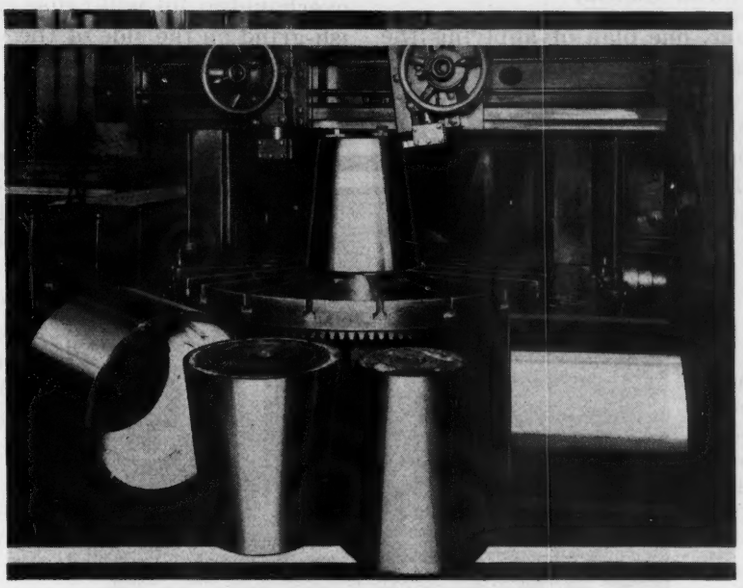


Fig. 1. Manganese Steel Rolls Too Hard to be Cut by Tools Previously Available are Readily Machined with Cemented Carbide

The choice of cobalt as the cementing medium is particularly fortunate. Cobalt, being non-carbide forming, does not impoverish the carbon content of the tungsten carbide. When tungsten-carbide particles are coated with an annular envelope of cobalt, compacted under great pressure, and the resulting briquettes heated to a red heat in a hydrogen atmosphere, the oxide films developed during handling and compacting are reduced, and the newly formed cobalt metal surfaces are lightly cemented together. The result is a material having a chalk-like consistency, which can be sawed, turned, or filed readily to the various shapes desired.

The next operation, called final sintering, finishes the product. The material then possesses all the well-known metallic properties, including high thermal and electrical conductivity, as well as brilliant luster, and, considering the great hardness, a considerable degree of strength and toughness.

The extrapolated Brinell hardness figure of tungsten carbide is between 1800 and 2400, as compared to 800, which is the ultimate for high-speed steel. The specific gravity of commercial grades is between 14 and 15. The linear coefficient of thermal expansion is approximately one-fifth that of ordinary carbon steel.

The cross-breaking or transverse rupture strength varies between 180,000 and 350,000 pounds per square inch, depending on the composition and treatment. High-speed steel tested under identical conditions shows values of from 250,000 to 400,000 pounds per square inch. It is apparent that almost anything added to tungsten carbide acts as a diluent and decreases the aggregate hardness. So it is with the cobalt content. As the per cent of cobalt increases, the hardness decreases, but the toughness increases in inverse ratio.

The compressive strength of the material, which is over 500,000 pounds per square inch, is in excess of that of any known material. Since there is no temper to be drawn, tools made of this material possess red hardness to a very high degree. The application of this material to cutting tools is usually accomplished by brazing, pressing, or otherwise fixedly attaching a tip of cemented tungsten carbide to a milled or shaped recess in a steel shank.

All Cutting Tools, Whether of the Carbide or High-Speed Steel Type, Require Care in Handling

The hard carbide materials have been subject to criticism because of certain precautions necessary in their application. The difficulty of grinding is cited as an obstacle to general use. In this respect, let us consider the case of high-speed steel. Its

successful application is far from a hit-or-miss affair. The heat-treatment of high-speed steel is one of the most difficult and delicate arts of modern metallurgy; yet we do not condemn high-speed steel because it necessitates careful treatment. In return for its special handling, it offers certain distinct advantages over previous cutting materials. So it is with cemented carbides. The slight extra effort required in applying tools of this material is generously repaid by greatly improved performance and tool life.

Design and Care of Tools Should be Under Centralized Control

For the average user, one plan of applying the super-hard cutting materials immediately suggests itself. One man, or preferably one department, should have full charge of the cemented-carbide tools. The responsibility for the design, purchase, introduction, records, and care of the tools is thereby centralized. It is imperative that accurate records, time study, and cost data be kept if the full utility of cemented-carbide tools is to be evaluated.

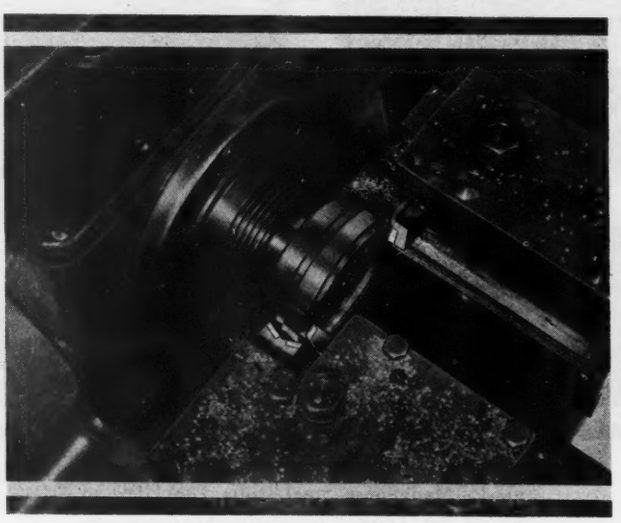


Fig. 2. Multiple Tools of Cemented Carbide Used on an Automatic for Machining Bronze Bushings; Speed, 500 Feet per Minute; Feed, 0.010 Inch per Revolution; 1000 Pieces per Grind

When all the tools are ground by one group, more consistent and successful results can be obtained than when each machine tool operator grinds his own tools. This method of "tooling up" a shop is not a theory, but is being used today in a number of plants with eminently satisfactory results.

Rules for Application Based on Experience

In order to make the most of the unique physical properties of cemented-carbide tools, certain precautions must be observed in their design and use, as outlined in the following rules:

1. To provide rigidity and support, use as large a shank as is practicable.
2. To dissipate heat and provide the necessary strength, make the tip as thick as possible.
3. In operation, support the tools as close to the cutting edge as possible.
4. Always disengage the feed and allow the cut to run out before stopping the machine.
5. Change the tool when it requires regrinding. Do not "push" it when dull. The use of honing stones will prolong the tool life between grinds and make frequent regrinding unnecessary. The best finish is produced by a sharp tool.
6. Use special, soft grinding wheels for sharpening cemented-carbide tools. Any of the well-known abrasive-wheel manufacturers will recommend proper grades.
7. Always grind so that the action of the wheel presses the tips more firmly against the shank support. Grind against the cutting edge always. Failure to observe this precaution may result in flaking or chipping of the cutting edge.
8. Never finish-grind front or side clearances on the periphery of a small wheel. The resultant overhanging lip will cause early tool failure. Finish-grind on the side of the wheel or on the face of a ring- or cup-wheel.
9. Never hammer or tap the tip when clamping in a vise or on a magnetic chuck. Avoid the use of set-screws or clamps that have a point bearing on the tip.
10. In regrinding tools, take care to grind them to the original tool angles and rakes. If changes are made, the reason should be given to the proper person.
11. Never dip the tip in water during grinding; the shank of the tool, however, may be immersed with safety.
12. Wet grinding, properly done, is faster, cheaper, and safer.
13. Use a flood of coolant when grinding wet. A little is worse than none.
14. Redress grinding wheels frequently.
15. Keep grinder spindle bearings clean and snug, and keep grinding wheel free from vibration.
16. Use a light pressure in grinding.
17. Keep clearances at a strict minimum.
18. Do not use more than 0.001 inch vertical feed per pass in surface-grinding cemented carbide tips.

Greater Care is Required in the Use of Carbide Tools than is Generally Given High-Speed Steel Tools

In applying the hard carbides to the cutting of metals, certain departures in design from conventional high-speed steel practice have been found of value. The importance of careful and accurate grinding to fixed tool angles and clearances cannot be over-emphasized. In the main, clearance angles —both side and front—have been markedly reduced to provide greater resistance to the shearing stresses set up during cutting. The cutting angles on carbide tools have also been changed for the same reason.

The introduction of the hard carbides for metal-cutting has been, from the start, a story of in-

creased precision and a superior "shop technique." Previous cutting tools have been indifferently or even carelessly ground. The machine tool operator frequently could not tell what clearance angles he had ground on his tools.

Steel cutting tools have been rather carelessly applied, sometimes being set above center and sometimes below. Frequently no one seemed to know what the practice was supposed to be. Manufacturers of cemented carbides have recommended that the tools be used on center, partly in order to insure that the minimum clearance would suffice to clear the work, and partly to prompt the machine tool operator to actually take measurements in setting the tool.

Diamond-Lapped Cutting Edges Increase Efficiency

Everyone who has used carbide cutting tools, especially for finishing cuts, knows that a very great increase in tool life is effected by diamond-lapping the cutting edges. Friction produces abrasive wear. The coefficient of friction of a moving metal chip toward a tool face must decrease as the fineness of the finish of the tool face is increased. Spectacular figures have been compiled to show the almost unbelievably larger number of pieces per grind obtained by carefully diamond-lapping the cutting edges of tools that had previously been finished by fine grinding only.

The writer has been told of an instance in which a shop superintendent, on observing the marked increase in efficiency that resulted from lapping his carbide tools, tried lapping steel tools, and was rewarded with proportionately better performance. Here we have a case in point where the proper application of carbide tools has pointed the way to more exact methods in the machining of metals with other tools.

Necessity for Large Tool Shanks

The reasons for recommending a larger shank for a carbide-tipped tool than for a steel tool are evident when we consider that by recessing the shank for the tip, we materially weaken its resistance to shear. Furthermore, if we select as a brazing material a substance possessing a high thermal conductivity, a large shank will afford a capacious heat reservoir into which the heat generated during cutting may be dissipated.

It is true that cemented-carbide tools possess red hardness to an unusual degree, but it must be remembered that actual plastic flow under the combined influences of heat and pressure may occur far below the temperature at which it would normally occur under the influence of heat alone. Inasmuch as carbide tools are expected to operate at higher speeds than high-speed steel tools, it follows that they must be capable of withstanding the proportionately greater impact loads and tool pressures resulting from increased cutting speeds.

Solving the Chip Problem

With carbide tools, chip disposal has become a very real problem. The chips, for instance, from a steel work-piece are frequently fast moving, sharp, and sufficiently hot to "blue" the metal. The use of chip-breakers or curlers in the form of a recess having the same side slope as the side rake angle of the tool, terminated by a fillet of suitable radius, has proved effective. These chip-breakers are commonly ground in the material itself, as shown in Fig. 4.

The conventional circular form tool is being replaced by the flat form tool since cemented carbide has removed the necessity for providing the maximum amount of metal in the smallest possible space to permit repeated grinding. Only in those cases where existing tool-holding requirements demand a circular type of form tool do we recommend this design.

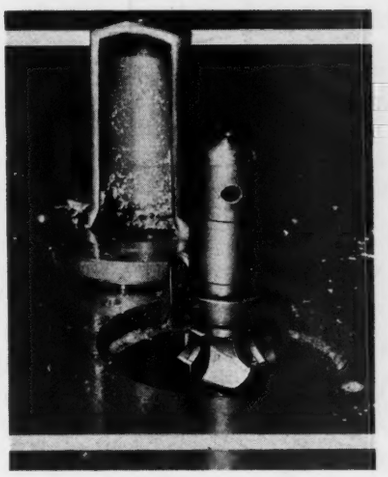


Fig. 3. A Tungsten-carbide Cutter after Trimming Die-casting Edges Having a Total Length of 28 Miles. The Tips have been Stoned but not Ground; Speed, 4250 Revolutions per Minute

In certain instances where high production with a minimum loss of time in making set-ups is of paramount importance, we find that it is advantageous to supply a circular form tool with two or more tips. When one contour loses its size or edge, the tool is merely indexed in the holder to the next position, and the cutting is continued. The manifold advantages of this practice are evident. The tool is removed from the machine for regrinding only one-half, one-third, or one-fourth as frequently as a single cutting-edge tool, depending on the number of cutting edges.

Designing Tools to Utilize the Tremendous Compressive Strength of Cemented Carbide

In our brief enumeration of the physical properties of cemented carbides, it was mentioned that while, compared to high-speed steel, these materials are inferior in point of resistance to shear and bending, their compressive strength is greater than that of any known material. In view of these specific physical properties, it is eminently the concern of engineers to so design tools as to take advantage of this great compressive strength and to minimize as far as possible the effects of shearing stresses developed during cutting. This point will be briefly analyzed.

The forces that act upon a lathe tool are three in number. They are represented in Fig. 5 by the lines *F*, *T*, and *R*. The feeding pressure *F* is directed against the side of the tool parallel to the axis of the work-piece; the radial pressure *R* acts against the end of the tool parallel to the axis of the tool, and the tangential pressure *T* is directed down on the top of the tool in a vertical plane.

These three basic forces are shown as the edges of a rectangular box viewed in perspective. The resultant of the three forces will, of course, be the diagonal *E* of the parallelepiped. This is the equivalent force, which, if acting singly, would produce exactly similar loading conditions as the three separate forces acting simultaneously.

It is this force, and in particular its direction, that we must consider in designing tools to take full advantage of the compressive strength and minimize the shearing action. Large shanks and minimum clearance angles assist in dealing with shear. Where conditions permit, either of the methods shown in Fig. 6 for obtaining a "push cut" may be used. With tools of these designs, the bulk of the resultant tool pressure is directed axially along the length of the tool shank. In this way, the compressive strength of cemented carbides is utilized.

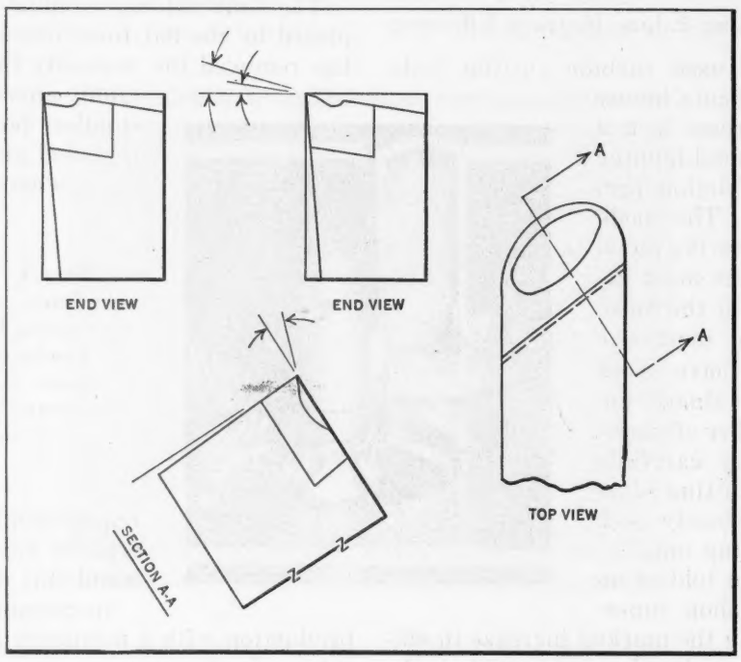


Fig. 4. Diagrams Indicating Method of Grinding Cemented-tungsten Turning Tool Tips to Break up Chips

We may use a dynamometer for accurately measuring the three separate forces *F*, *T*, and *R*. From these measurements, the resultant force *E* can be readily calculated. The use of this equipment in proposed investigations of the influence of the cut, speed, and feed conditions upon the acting forces will doubtless bring to light many interesting data.

Simple Calculations Show Need for Heavy Tool Shank and Powerful Drive

In recent years the trend has been toward heavier, more powerful, and more rigid machine tools. This trend has been given a decided impetus by the requirements of the new cutting metals. A simple arithmetical calculation suffices to show that to take a 1/2-inch cut on a steel shaft under a feed of 1/16 inch per revolution at a peripheral cutting speed of 150 feet per minute requires a power consumption of approximately 45 horsepower.

Ordinary engine lathes of today are not capable of assuming loads of this magnitude, and yet this does not in any way approach the cutting capacity of cemented-carbide tools. When we further consider that under the conditions stated, the tangential force exerted on the tool is in the neighborhood of 8500 pounds, the plea for large shanks is far from unreasonable.

Performance Records of Cemented-Carbide Tools

The real value of cemented-carbide tools should be judged by their performance records on actual production work. A few noteworthy records on various classes of work are given in Table 1. This table gives some idea of what has been accomplished, not in tests, but under actual production conditions in various plants. The table does not in any sense embrace all the applications on which cemented carbides have been remarkably successful.

Cemented tungsten carbide is proving a serious competitor of diamonds, both in the field of core-drills for exploration purposes, and in the cutting-tool field. The diamond, being a crystalline substance, is subject to planes of weakness or "easy slip." Shear is, therefore, frequent along these slip planes. The cemented-carbide tool materials are not subject to this inherent weakness and are much more resistant to shock than diamonds.

In the production of automotive ignition parts, metal contacts and leads are molded integrally with the insulating hard rubber, Bakelite, and other synthetic plastic materials. When diamonds are used to finish these molded parts, a separate machining operation is necessary to under-cut the metal portions below the depth to which the diamond will cut; otherwise, breakage of the diamond results. For work of this kind, tungsten-carbide tools are of great advantage, as they readily perform the entire machining work without changing tools. In fact, this proved to be one of the first definitely successful applications.

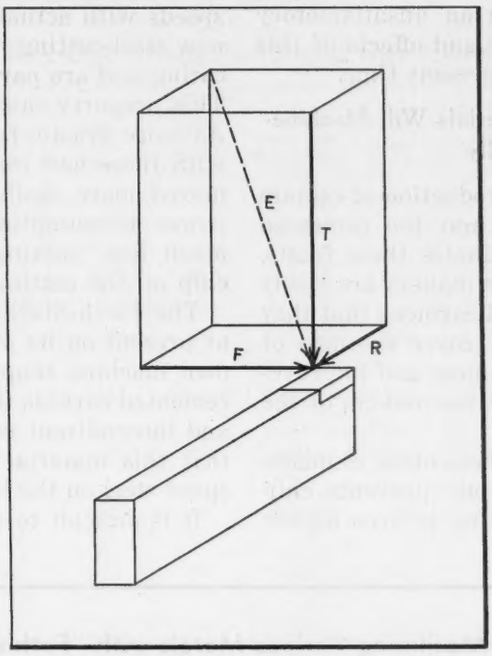


Fig. 5. Diagram to Indicate the Resultant Direction and Magnitude of the Forces Acting on a Turning Tool

Advantages of Cemented-Carbide Tipped Milling Cutters

In the field of milling, the cemented-carbide tools have been particularly successful. It is significant that carbide-tipped milling cutters cut through the chilled, intensely hard and sandy surfaces of castings almost as readily as through the softer interior metal. Such applications as the face-milling of cast-iron motor blocks, which formerly required two cuts with high-speed or cast-alloy tipped cutters, in order to remove the scale and produce the required finish, are now handled in one cut with tungsten-carbide tipped cutters.

The facility with which these cutters cut through the hard surfaces of castings has made it possible to change the patterns so that less stock is allowed for finishing. Foundry costs have thereby been materially reduced. Feeds and speeds have been advanced to almost unbelievable values.

Table 2 summarizes the operating conditions that were maintained during a week's demonstration of carbide-tipped face-milling cutters at the plant of the Kearney & Trecker Corporation. At the present time, extensive tests on the milling of steel are being conducted at the Milwaukee plant of this company. The results thus far are most encouraging.

Grades of Cemented Carbide Made to Suit Cutting Requirements

The need for various grades of cemented-carbide cutting materials was early recognized. The day of a cutting medium of broad applicability is long past. The highly competitive spirit that obtains among the several manufacturers of this material has made necessary the constant improvement of the material and the diversification of the properties of the various grades.

In developing the several grades that are today produced as standard materials, the makers selected two bases upon which to make the classification. These bases are: (1) The kind and type of material to be cut; (2) the class of cutting that is contemplated.

Today a grade is manufactured for general-utility purposes on average machining work; a grade that is particularly suited to machining the harder metals at moderate depths of cut and feed; two grades for shallow fast-finishing cuts with light feeds, where excellence of finish and maintenance of size within narrow limits are requisites; and duplicate grades whose properties peculiarly suit them to the machining of the various types of steel.

If the prospective customer informs the carbide manufacturer what type of material is to be cut, the average depths of the cuts, and the feeds and speeds that are contemplated or desired, the grade that will be most effective can be furnished.

Difficulties First Experienced in Cutting Steel Overcome by Improved Cemented Carbide

The cutting of steel with cemented-carbide tools has received careful attention. Although there are numerous successful applications of ordinary cemented tungsten carbide to the machining of steel, the formation of a chip cavity on the top face of the tool, caused by the action of the hot steel chip in passing across this surface, has been a source of annoyance. As cutting is continued, this cavity is progressively enlarged.

Finally, although the origin of the chip cavity and its deepest point are always located an appreciable distance behind the cutting edge, the cavity assumes such proportions that the wall between the outer rim of the cavity and the front face of the tool becomes so thin as to cause part of the nose of the tool to shear off. A disproportionately large amount of the costly carbide must then be ground away in redressing the tool.

Another disturbing factor is the tendency for a false cutting edge to form, composed of laminated and compacted particles from the steel work-piece itself. This built-up cut-

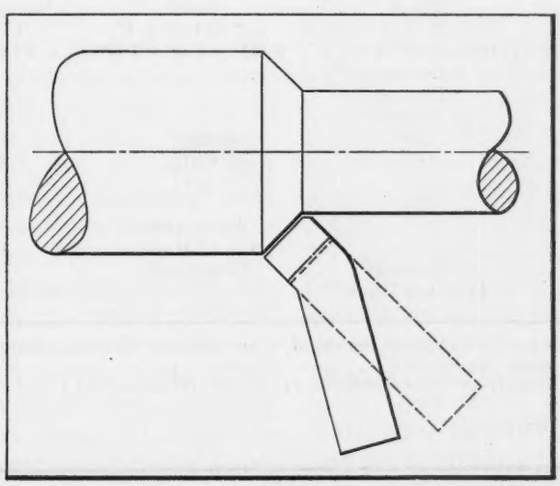


Fig. 6. Outlines of Turning Tools with Shanks Arranged to Effectively Resist Cutting Forces

ting edge frequently results in an unsatisfactory finish on the work. The nature and effects of this crust are being studied at the present time.

Newly Developed Carbide Materials Will Machine Steel Successfully

It has been found that the introduction of certain elements other than tungsten into the cemented carbides almost completely eliminates these faults, and at the present time, carbide makers are ready to recommend grades of sintered carbides that they feel confident will satisfactorily cover the field of steel cutting as a whole. Development and improvement, of course, never cease, but the makers of the product have gone a long way.

Fortunately, the infusion of these other elements into the sintered material not only prevents chip cavities, but also permits of cutting at even higher speeds with actually *less* generation of heat. The new steel-cutting materials are partially self-lubricating and are particularly poor absorbers of heat. This property causes the heat to stay in the chips. As more drastic rakes and tool angles are possible with these new materials, the chips seem to be removed more easily, and proportionate savings in power consumption are effected. Also, there is much less "seizing" or adhering of a "built-up" chip on the cutting point.

The Firth-Sterling Steel Co. is conducting tests at present on its own testing equipment and in its own machine shop on a new steel-cutting type of cemented carbide that is suitable for heavy hogging and intermittent cuts. The laboratory tests show that this material is actually tougher than high-speed steel on the basis of transverse-rupture tests.

It is difficult to attempt to forecast the ultimate

Table 1. Results Obtained in Machining Various Metals with "Firthite" Cemented-Carbide Tools

Data on Machining Operations	Kind of Material Machined			
	Aluminum Alloy "Lo-Ex"	Aluminum Alloy "Lynite"	Yellow Brass Casting	Hard Bronze
Part Machined	Motor Piston	Motor Piston	.....	Cover Plate
Operation	Turn Skirt	Groove	Turn	Face
Machine Tool Used	Special 10" Lathe	Baird Piston Machine	Warner & Swasey	Warner & Swasey
Cutting Quality of Material	Highly Abrasive	Highly Abrasive	Good	Abrasive
Size of Tool	5/8" x 5/8" x 3 1/2"	5/32" x 1/2" x 5 1/2"	.....	1" x 1" x 7"
Size of Tip	3/16" x 3/8" x 5/8"	3/16" x 5/32" x 3/4"	.....	1/4" x 3/8" x 7/8"
Clearance Angle on Tool	12 Degrees	7 Degrees	.....	6 Degrees
Back Slope Angle on Tool	18 Degrees	.....	.....	.....
Side Slope Angle on Tool	.....	.....	.....	12 Degrees
Cutting Speed, Feet per Minute	570	150	458	425
Feed, Inch per Revolution	0.0312	.....	0.108	0.024
Depth of Cut	1/8"	.....	3/32"	3/16"
Metal Removed per Minute, Cu. In.	27	.....	56	23
Number of Pieces per Grind	182	1500	600	50
Time Between Grinds	.....	.....	6 Days	.....
Number of Pieces per Hour	.....	.....	11	.....
Savings in Labor Cost	.....	.....	82 Per Cent	.....

Data on Machining Operations	Kind of Material Machined			
	Cast Iron	Semi-steel Castings	Manganese Steel*	"Duraloy"†
Part Machined	Gray Iron Pistons	.....	Brick Yard Rolls	Pipe
Operation	Facing	Turning	Turning	Turning
Machine Tool Used	36" M.D. Lathe	Baird Chucking Mch.	60" Bullard Mill	30" Engine Lathe
Cutting Quality of Material	Good	Good	Never Before Cut	Extremely Hard
Size of Tool	7/8" x 1 3/4" x 9"	1/2" x 1/2" x 4"	1" x 1" x 7"	7/8" x 1 3/4" x 9"
Size of Tip	7/16" x 7/16" x 1 3/4"	5/32" x 1/4" x 5/8"	1/4" x 1/2" x 5/8"	1/4" x 1/2" x 3/4"
Clearance Angle on Tool	6 Degrees	.....	.....	4 Degrees
Back Slope Angle on Tool	5 Degrees	.....	.....	0 Degrees
Side Slope Angle on Tool	10 Degrees	.....	.....	3 Degrees
Cutting Speed, Feet per Minute	250	280	34‡	44‡
Feed, Inch per Revolution	0.070	0.012	0.0625‡	0.047‡
Depth of Cut	1/4"	1/8"	1/8"	3/16"
Metal Removed per Minute, Cu. In.	53	5	3.2	4.7
Number of Pieces per Grind	.....	550 to 1080	.....	.....
Time Between Grinds	.....	9 to 17 Hours	4 Hours	.....
Time per Piece	30 Seconds	25 Seconds	7 Hours	.....
Savings in Labor Cost	$3.90 per Piece	.....	$12 to $14 per Roll	.....

*These manganese steel brick yard rolls have a manganese content of 13 per cent and a carbon content of 1.2 per cent. They have never before been cut with an edged tool, the hardness being 250 Brinell.

†This "Duraloy" is in the form of centrifugally cast pipe containing 24 per cent chromium and 12 per cent nickel. It is extremely hard and has sand embedded in it to a depth of 1/8 inch.

‡These speeds and feeds apply to roughing cuts.

Table 2. Data on Typical Milling Operations Performed with Cemented-Carbide Tipped Cutters

Part Milled	Cutter Used		Depth of Cut, Inch	Table Feed, Inches per Minute	Feed per Tooth, per Revolution, Inch	Spindle Speed, R.P.M.	Surface Speed, Feet per Minute	Remarks
	Diam., Inches	No. of Teeth						
Cast-iron Gear Cover	5	10	1/8	17	0.00813	209	275	Fragile casting; intermittent cut; step milling; time, 105 seconds
Cast-iron Cylinder Head	9	18	1/8	21	0.00890	130	307	Intermittent sweep cut; time, 75 seconds
Cast-iron Manifold	4	10	1/8	52 1/2	0.01230	355	370	Intermittent cut; time, 25 seconds
Cast-iron Oil-pan	4 6	10 12	1/16 3/32	21 21	0.00700 0.00580	300 202	315 315	Duplex milling; two heads; time, 45 seconds
Cast-aluminum Cover Plate	6	12	1/8	80	0.00810	820	1285	Intermittent cut; time, 5 seconds
Cast-aluminum Test Block	4	10	3/32	100	0.01000	1000	1050	Steady sweep cut; time, 6 seconds
Cast-iron Magneto Bracket	4	10	1/8	20	0.00660	303	318	Intermittent cut; time, 45 seconds
Cast-iron Pump Body	3	10	3/32	26	0.00860	303	318	Intermittent cut; time, 10 seconds
Cast-iron Block	End-Mill	Two-Lip	1/8	17	0.00570	1500	...	Steady cut

significance and possible future of the carbide tools. In the past, the preponderance of stress has been placed upon the ability of these tools to increase production, lower machining costs, and decrease idle machine time and frequency of grinding.

In times of economic stress such as these, the argument of increased production is neither particularly forceful nor convincing. The real benefit, which will inevitably accrue to all of us, will be reflected by the ability of these new tools to untie the hands of metallurgists, engineers, and designers. For years, metallurgists have known of strong and tough alloys which could not be used as materials of construction and machinery parts because of the seemingly insurmountable machining difficulties. Now that tools have been developed that are capable of machining such alloys, research and design will be definitely stimulated.

The cemented carbides for cutting tools are here to stay. The experimental stage is almost over. On every side we hear statements from eminent authorities in the automotive and other high-production industries to the effect that this alloy and that material can be *economically* machined *only* through the use of cemented-carbide tools.

Everyone who has witnessed these tools in operation knows that they possess certain definite advantages over tools of any other cutting material yet developed. More and more we see large organizations "tooling up" with carbide tools. They keep accurate cost and time study data, yet they continually buy and use more tools. They are rewarded with increased production at lower costs. This means that, inevitably, competing organizations that desire to stay in the race will be forced to use cemented-carbide tools.

* * *

New Material for Absorbing Vibrations

A new product known by the trade name of "Keldur," which is a thoroughly time-tested synthetic material originally developed in Germany and now manufactured and sold by the Keldur Corporation, 26 Avenue B, Newark, N. J., has recently been made available to American industry. This product, which is intended for absorbing vibrations in machinery and structures, is obtainable in sheets of from 1/4 to 1/2 inch thick, and up to 3 feet square. The 3/8 inch thickness is the one most commonly used.

The material resembles a very soft rubber; it will not bounce, but returns to shape slowly. Oils do not affect it, but it is somewhat affected by long exposure to water, and should not be used without protection in locations where it will be kept wet much of the time. It is suitable to use at ordinary atmospheric temperatures, but is not recommended for use at temperatures above 140 degrees F. Ordinarily, it should carry a load of at least ten pounds per square inch, but not above thirty pounds per square inch. It is practically incompressible volumetrically, resembling rubber in this respect more than cork. Another characteristic of this material is that it will not slip, but clings to metals and other solids.

Determining the Value of Tungsten-Carbide Milling Cutters

A Series of Experiments Conducted for the Purpose of Ascertaining the Factors Underlying the Successful Application of Tungsten Carbide to Milling Operations—First of Two Articles

By B. P. GRAVES, Director of Design
Brown & Sharpe Mfg. Co., Providence, R. I.

TUNGSTEN carbide is suitable for use in many milling cutters. Frequently a saving in time and cost results; on the other hand, the use of this cutting alloy may cause a loss if not properly applied.

Recent tests conducted at the Brown & Sharpe Mfg. Co.'s plant in milling cast iron have brought out some valuable information. These tests were conducted to determine what changes would be necessary in machine tools to make them suitable for the application of tungsten carbide. Since it was believed that the use of tungsten carbide would necessitate some changes in cutter design, rate of feeds and speeds, etc., these matters were closely observed. Arrangements were also made to keep a record of the power consumed in these tests as a further aid in determining the changes that would be necessary in the design of machine tools and cutters.

Previous to making these tests, very little accurate data was available as to the performance of tungsten carbide. It was realized that if tungsten carbide were to become a practical tool in the plant, it must first prove to be a sound economic investment. Accordingly, an equation was formulated, which, when solved for values obtained in high-speed steel tests, indicated what performance would warrant the use of tungsten carbide.

For convenience in computing the results of the tests, this equation was expressed in two forms: The first represents the cost per piece of work machined; the second, the cost of machining per linear inch. In each equation, the cost includes depreciation, but not interest.

$$C_p = \frac{C_c}{P_g \times (N_g + 1)} + \frac{G_t \times G_r \times K}{60 \times P_g} + \frac{C_h \times M_r}{60 \times P_g} + \frac{T_p \times M_r}{60}$$

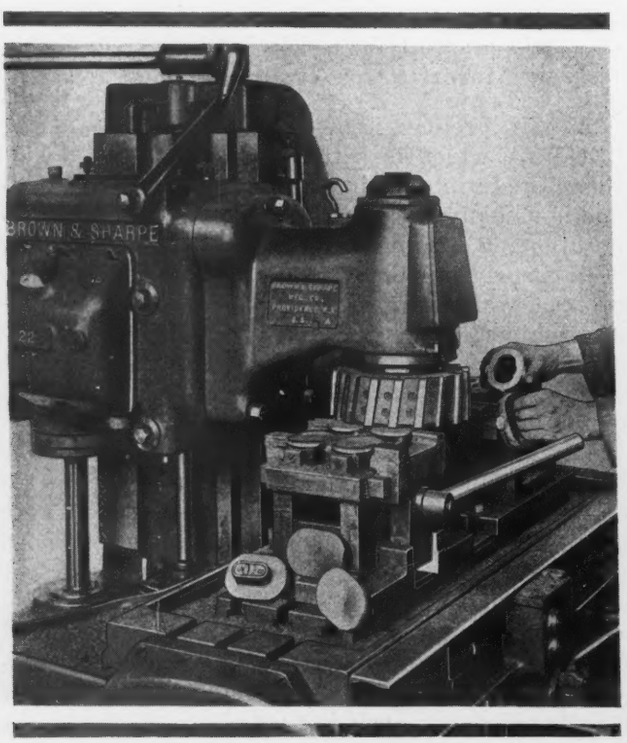


Fig. 1. Milling Pump Housings and Caps with a Cutting Speed of 228 Feet per Minute and a Table Feed of 24 Inches per Minute—350 Cycles between Grinds

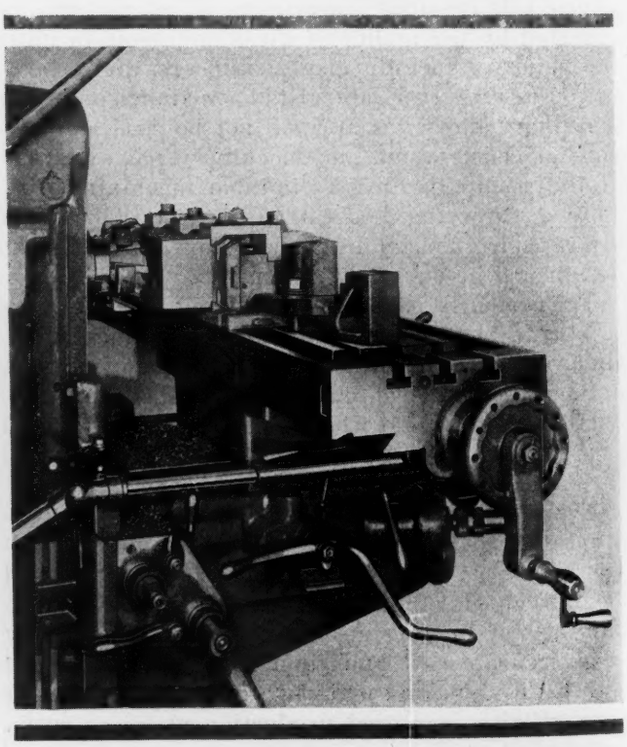


Fig. 2. Milling Cast-iron Test Blocks with a Cutting Speed of 236 Feet per Minute, a Table Feed of 23 1/4 Inches per Minute, and a Depth of Cut of 1/10 Inch (Test 43)

$$C_l = \frac{C_c}{I_g \times (N_g + 1)} + \frac{G_t \times G_r \times K}{60 \times I_g} + \frac{C_h \times M_r}{60 \times I_g} + \frac{C \times M_r}{60 \times I_m}$$

In these formulas,

C_p = sum of cutter, machine, and labor cost per piece, in dollars;

C_c = purchase price of cutter, in dollars;

P_g = number of pieces machined per grind of cutter;

N_g = number of grinds in life of cutter;

G_t = time to grind cutter, in minutes;

G_r = rate charged for grinding per hour, in dollars;

C_h = time required to change cutter for grinding, in minutes;

M_r = milling machine rate per hour, in dollars;

T_p = average time required per piece, in minutes (equal to 60 divided by the net production per hour);

K = a factor equal to the number of grinds divided by the number of grinds plus 1;

C_l = total cost per linear inch cut, in dollars;

I_g = linear inches of metal cut per grind of tool;

I_m = cutting rate per minute of feed, in inches; and

C = a factor equal to gross time required per piece divided by the net time of cutting.

The first term of the first equation represents the cost of the cutter per piece machined. It will be noticed that the actual number of grinds in the life of the cutter is expressed by the term $(N_g + 1)$. This is based on the assumption that the cutter has been ground before being placed in stock and, accordingly, the expense of one grinding will be included in the initial cost. The second term of the equation represents the cost of grinding the cutter per piece machined. The third term represents the cost of changing the cutter for grinding, while the last term includes the cost of machining the piece at the regular rate charged in milling machine practice.

The Basis for Evaluating the Gain Due to Using Carbide Cutters

In the tests, the performance of high-speed steel cutters was used as a basis for selecting the feed, speed, etc., for the tungsten-carbide cutters. For instance, a 9-inch diameter high-speed steel inserted-tooth cutter, operating at a speed and feed that approximated the conventional values, gave a certain performance, represented by the number of cubic inches of stock removed, the total minutes of actual cutting time, and the life between grinds. The cost per piece determined by the equations given above, using this high-speed steel cutter data, was then used as a value that should be bettered by tungsten carbide if it were to prove successful.

It is quite evident that, for short jobs requiring individual cutters, the first term of the equation—namely, the cost of the cutter—represents the greatest part of the cost per piece or cost per inch; and only when a job is of sufficient length to reduce the value of the first term of the equation in comparison with the other three will tungsten carbide be a sound economical investment.

Table 1. Cutters Used in Tests

Type of Cutter	Diameter of Cutter, Inches	Material of Cutter*	Number of Teeth
Solid End-mill	1	H.S.S.	6
Tipped End-mill	1	T.C.	6
Solid End-mill	1 1/2	H.S.S.	8
Tipped End-mill	1 1/2	T.C.	8
Shell End-mill	3	H.S.S.	10
Shell End-mill	4 1/2	H.S.S.	14
Shell End-mill	6	H.S.S.	18
Inserted-blade.....	6	T.C.	6
Inserted-blade.....	6	T.C.	12
Inserted-blade.....	6	H.S.S.	18
Inserted-blade.....	7	T.C.	12
Inserted-blade.....	9	H.S.S.	14
Inserted-blade.....	9	H.S.S.	16
Inserted-blade.....	9	H.S.S.	18
Inserted-blade.....	9	T.C.	18

*H.S.S. = High-speed steel. T.C. = Tungsten carbide

About 600 minutes was assumed to be a fair value for the life between grindings of tungsten carbide, and in a number of the tests, it actually did approximate this value. Any combination of speed, feed, chip per tooth, number of teeth, etc., that gave a performance in excess of 600 minutes was, of course, encouraged; but it was believed that the use of a tungsten-carbide cutter that failed before cutting for 600 minutes on cast iron would not result in any saving over high-speed steel cutters.

It is worthy of mention that the results obtained in some of the tests using high-speed steel cutters exceeded the performance that would ordinarily be expected in common machine shop practice. This fact suggests that *if the same attention that is now given to the newer cutting alloys were given to high-speed steel, the performance of the latter would be much more efficient.*

The tests were made on the following machines:

No. 22B plain, Brown & Sharpe milling machine with spindle speeds from 25 to 620 revolutions per minute and a feed range of from 1 to 39 1/2 inches.

No. 2B high-speed, plain, Brown & Sharpe milling machine with spindle speeds from 20 to 1300 revolutions per minute and a feed range of from 1/2 to 62 inches.

No. 3 standard, vertical-spindle, Brown & Sharpe milling machine with drive shaft running at 700 revolutions per minute, spindle speeds from 34 to 810 revolutions per minute, and a feed range of from 13/16 to 32 1/4 inches.

All set-ups were made rigid. The work was kept close to the fixture, which was made as low as possible in order that the cutting surface would be

Table 2. Results of Tests on 1-Inch Tungsten-Carbide Tipped End-Mills

Test No.	Speed, Feet per Minute	Table Feed, Inches per Minute	Chip per Tooth, Inch	Total Length of Cut, Inches	Actual Cutting Time, Minutes
15	338	47.25	0.0061	2,256	49
17	273	38.00	0.0061	7,760	213
23	215	38.00	0.0075	29,550	738
3	183	28.00	0.0066	24,420	872

close to the machine table. The cutter was attached rigidly to the adapter or spindle and carefully checked for run-out. In all comparable tests, the cutter was run in the same direction. The cutters were accurately ground and the time recorded. In each test, the cutter was used until the cutting edge was dull, but not abused. Table 1 lists the cutters used in the tests.

What the Tests Were Intended to Show

In all the tests, an attempt was made to use only such combinations of feeds and speeds as would give a reasonable performance. In several instances, however, the speed used was too great and the cutter failed after a very short run. The real purpose of each test was to assist in determining the most economical conditions for the use of tungsten-carbide cutters. When a test block was used for the work-piece, the depth of cut was kept uniform for each test. No attempt was made to determine either the maximum amount of stock the cutter would remove or the maximum rate at which the cutter would operate.

Power readings were also taken, and the following values recorded: (1) Motor alone; (2) motor and machine spindle; (3) motor, machine spindle, and table feeding idle at feed used in test; (4) motor, machine spindle, and table feeding under cut.

Recording the Results of the Tests

Four tests were conducted using 1-inch diameter, 6-tooth end-mills tipped with tungsten carbide. These are listed as Tests 15, 17, 23, and 3 in Table 2. In all the tests conducted, the material machined was cast iron. The chip per tooth varied between 0.006 and 0.0075 inch, and the depth of cut was 1/8 inch in all tests.

A glance at the results of the four tests listed in Table 2 might indicate that the cutter data were chosen at random. Further study, however, will reveal that each test was outlined after a careful consideration of the results of previous tests. The final results show that Test 23 gives the most economical performance, with an actual cutting time of 738 minutes, and a length of cut of 29,550 linear inches. In Test 3, the cutter operated for 872 minutes before it was necessary to regrind it; but in this time the stock removal was represented by only 24,420 linear inches, 5130 linear inches less than the amount cut in Test 23, in a time greater by 134 minutes.

Tests 15, 17, and 3 were made several weeks before Test 23 was outlined. In Test 15 it is quite evident that either the speed of the cutter or the feed is in error. The reduction of speed in Test 17, with no decrease in the chip per tooth, gave a performance represented by an actual cutting time of 213 minutes, as compared with 49 minutes in Test 15. This would indicate that the speed in Test 15 was responsible for this poor result.

Before conducting Test 23, several other tests had been made with 1 1/2-inch diameter cutters and 6-inch diameter cutters. The results of these tests showed that the correct speed is probably somewhat over 200 feet per minute. The data used in Test 23 was then selected, leaving the feed the same as in Test 17, but bringing the speed down to 215 feet per minute. This increased the chip to 0.0075 inch, gave an actual cutting time of 738 minutes, and removed 29,550 inches of stock, as previously outlined. It is not possible to conclude from these tests that Test 23 represents the best conditions, although a study of the tests on the other cutters will determine more closely the correct cutter data.

Table 3. Results of Tests on 1 1/2-Inch Tungsten-Carbide Tipped End-Mills

Test No.	Speed, Feet per Minute	Table Feed, Inches per Minute	Chip per Tooth, Inch	Total Length of Cut, Inches	Actual Cutting Time, Minutes
16	263	38	0.0071	9,650	232
41	214	38	0.0087	21,500	605

On the same machines, the two tests in Table 3 were conducted with 1 1/2-inch, 8-tooth, tungsten-carbide end-mills.

Test 16, with a speed of 263 feet per minute, gave an actual cutting time of 232 minutes. Later it was decided that just as Test 23 varied with reference to Test 17, a reduction in the speed of the 1 1/2-inch end-mill should give an increased cutter life between grinds and an increase in the rate of stock removal. These two tests afford an excellent example of the effect of a change in speed. Since the feed in each case is 38 inches per minute, there is no increase in the rate of stock removal; but Test 41 has a distinct advantage in that it takes less than

Table 4. Results of Tests on 6-Inch Tungsten-Carbide Tipped Face Mills (Inserted-Blade Type)

Test No.	Speed, Feet per Minute	Table Feed, Inches per Minute	Chip per Tooth, Inch	Total Length of Cut, Inches	Number of Teeth	Actual Cutting Time, Minutes
19	267	14.375	0.0141	1,320	6	115
43	236	23.250	0.0129	21,020	12	1036
13	235	9.300	0.0104	9,150	6	1181
24	227	11.000	0.0126	9,656	6	1006

one-half the grinding time required by the cutter used in Test 16.

Tests with Inserted-Blade Cutters

The four tests with 6-inch diameter inserted-blade cutters listed in Table 4 were conducted for the most part after the tests on the 1-inch end-mills.

Tests 13, 19, and 24 were run with cutters having six teeth. Of these three, Test 13 gave the greatest time between grinds, while Test 24 gave the greatest production per minute. Up to this time, all tests indicated that the proper range of chip per tooth was from 0.007 to 0.013 inch. Therefore, in order to increase production on the 6-inch diameter cutter without increasing the speed or the chip per tooth, it was necessary to use more teeth. This was done, and Test 43 was conducted with a 6-inch diameter cutter having 12 teeth instead of 6. The feed was raised to 23 1/4 inches per minute. This kept the chip per tooth less than 0.013 inch. The result of this test was a production of 21,020 inches in 1036 minutes. The increase in the number of teeth increased the power consumption by about 70 per cent.

A PROGRESS RECORD IN THE ART OF CUTTING METAL

Before Test 43 was completed, it was estimated that if a prediction should be based on the theory that each tooth would do a certain amount of work if not abused, this test should show a production of from 14,000 to 19,000 inches, or an amount double that obtained with the 6-tooth cutters. The results of this test again indicate that the probable speed to be used with tungsten-carbide tipped cutters milling cast iron is approximately 200 to 235 feet per minute.

The results of additional tests and the conclusions to be drawn from the tests will be given in the second installment of this article.

Stabilizing Production Costs by Predetermining Piece-Work Rates

By B. C. BOOTH, Superintendent Radio Division
Brunswick Radio Corporation, Muskegon, Mich.

In past years, when we started production at the beginning of the season or began a new job, we always ran on a day-work basis until rate-setters could make time studies of the operations performed. In many cases, this required several weeks, especially in the punch press and machine departments, where the operations were short. This method caused a great amount of trouble for the time and cost departments, and allowed far too much day work.

This year we decided to try a method of rating all jobs before they were started. No time-study men were hired and only one of the time-study men previously employed was retained for this work. His duties were to prepare routing lists for parts and assemblies, using the production drawings and samples supplied by the engineering department. He filled in the production rate per hour from records of similar jobs. When there was no precedent to follow, the production was estimated at a conference of the superintendent, rate-setter, tool supervisor, and foreman. The rate-setter then only had to convert production per hour into hours per hundred, and make up his various group schedules.

New employes were ordinarily given a training period of one to three days at day-rate pay, the number of days depending on the nature of the job; in rare cases, a week was allowed. After a group was under way, no training period was allowed any new employe who entered the group.

In two instances, when new methods were to be tried out and there was a difference of opinion regarding the proposed rate, two rates were set, one being guaranteed for six weeks, and the second taking effect at the end of the six-week trial period. In these cases, the operators were informed at the beginning that the rate would be changed on a certain date, and they were told what the change would be. In one of the cases, however, the rate was not changed, for the second rate had been set too low. In the other, the rate change brought not one dissenting word. As our season draws to a close, a check-up reveals that our productive day-work is much less than for previous years, and that variation in costs due to this uncontrollable item has been very low.

* * *

General Electric Makes Awards

Twelve factory employes, eight engineers, and two salesmen with the General Electric Co., have won recognition for constructive ideas under the award established by the company in 1922 as a tribute to its first president, Charles A. Coffin. Four of the winning suggestions had to do with the manufacture of electric refrigerators, four were concerned with electric welding, and three were for the development of a new substance known as Thyrite, which has the remarkable characteristic of being a good electrical insulator at low voltages and an excellent conductor at high voltages. The other awards were made for various improvements in design and manufacturing methods.

Guaranteeing the Performance of Tools

Tool Manufacturers Should Not Follow the Practice of Guaranteeing Performance Without a Knowledge of All the Factors Involved

By C. B. COLE, President
Tool Equipment Sales Co., Chicago, Ill.

SOME manufacturers, in buying small tools, request a guarantee of performance. This practice is responsible for increasing the cost of selling tools and tooling equipment considerably. There are what might be called hidden conditions on every tooling job that cannot be readily determined by the tool salesman or sales engineer. This information, therefore, cannot be transmitted to the factory making the tools. Without a thorough understanding of the conditions, it is not possible to make a guarantee and be sure that it can be lived up to.

The usual procedure is for a shop executive to ask a salesman to call and then show him a job on which he is anxious to increase production; probably he wants to reduce tool costs at the same time. Sometimes it is pointed out to the salesman that his competitor's tools are used on the job and that there is a chance for him to obtain some business if he can produce better tools at a lower cost.

How it All Begins

Obviously, the salesman is anxious to get additional business, and after looking over the job, he will submit the data that he obtains to his factory. In due course, a quotation is submitted. In this quotation the shop executive has requested floor-to-floor time, pieces per grind, and a definite guarantee that the tools will perform as stated. The shop executive then issues a requisition, and an order is placed for these tools. On the order it is stated that the supplier is to definitely guarantee the performance of the tools; in the event that they do not give complete satisfaction, they are to be returned for credit.

This means that the tool manufacturer is holding the bag, without any possible risk to the buyer. If the tools work out satisfactorily, the buyer obtains the benefit of increased production and lower costs. If they do not, the manufacturer sometimes has to alter the tools in an endeavor to make them work, or in some cases replace them entirely. This means that the salesman has to go back and forth to this plant until the job is running satisfactorily.

The procedure might be good business in some cases, when the quantity of tools purchased runs into a large volume, but this is not always the case. It is the experience of the writer, in some instances of this kind, that, after having "licked" a difficult job, the design of the part is changed and there is no further business on tools of this type. When this happens, it means loss to the tool manufacturer, as he cannot charge the customer for the experimental work or for the time of his salesman. Profits on jobs of this kind are dependent on repeat business.

Selling tools on this basis is the cause of much grief to the tool manufacturer. Even if a manufacturer has wide experience on similar classes of work with the same materials, there are other factors that must be taken into consideration, such as differences in shop conditions and machine tools—to say nothing of the human element, the operator. Therefore, the small tool manufacturer who is guaranteeing a definite performance of the tools he sells is going to find his sales costs very high.

Where it is Safe to Guarantee Production

Throughout the country today there are quite a few manufacturing plants where tools can be sold on the guarantee basis without any risk on the part of the tool manufacturer. This is due to the fact that, despite all the information that has been published in the technical journals on modern production methods, some plants do not seem to be aware of the fact that there have been changes in tooling practice. They have not changed their methods for a number of years; and the strange part of this is that they are not small plants, but in a great many cases good-sized organizations.

In a plant of this type, it is very simple for the tool salesman, whenever he can get the opportunity, to show wonderful increases in production and to lower tool costs considerably. On the whole, however, the tool manufacturers are adding a great deal of unnecessary expense when they make definite guarantees on jobs on which they do not have all the necessary data for determining whether or not their tools will do the job satisfactorily.

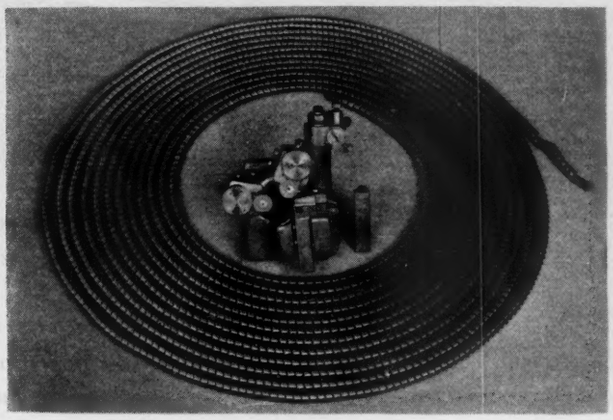
The Customer Should be Asked to Do His Part

It would seem only fair that some of the burden of guaranteeing tool performance should be put on the customer by requesting him to furnish all the information possible regarding the job for which the tools are to be used. He should also furnish the results of any experiments that he might have made.

If the practice of guaranteeing performance is not handled carefully, the small tool manufacturers will be in the same position as some of the machine tool builders are today. Not only are they required to guarantee the floor-to-floor time of the parts to be machined, but they are asked to guarantee the life of the machine, and, in addition, to send an instructor or demonstrator to teach the customer how to use the machine. Often they have to take, in trade, an old machine that has been sold to the customer ten or fifteen years previously—a machine having little or no resale value.

Experiments with Cemented Tantalum Carbide for Turret Lathe Operations

Recording Some of the Results that have been Obtained in Machining Steel on Turret Lathes of Modern Design



By M. E. LANGE, Production Engineer
The Warner & Swasey Co., Cleveland, Ohio

WHEN cemented tungsten carbide was first introduced to the trade, it was expected that this new cutting material would be equally successful on cast iron, non-ferrous metals, and steel. This impression, no doubt, was strengthened by the fact that high-speed steel cutters were being used over this whole range of metals and were giving entirely satisfactory results.

However, this did not prove to be the case. While the field for machining the first two materials was constantly broadening, it was soon discovered that cemented tungsten carbide was practically a failure on steel. Fortunately, the substitution of tantalum or other rare metals for tungsten has recently opened up a field for intensive and profitable laboratory work. This development has reached a very promising stage at the present time for cutting both the carbon and alloy steels encountered in production. In fact, one cannot help marveling at the rapid progress being made by the scientists who are engaged in this front-line pioneering work in metallurgy.

Because of the very low activity in the field, few industrial applications of cemented tantalum-carbide cutters have been made that have had a sufficiently long run to enable conclusive deductions to be drawn; hence, it is difficult to cite more than laboratory data at the present time. Experimental metal-cutting work generally has to be carried on under conditions far removed from what is encountered in actual shop use. The average actual roughing cut employed in production is seldom more than 3/16 to 3/8 inch deep on castings, and but little more on the average bar job. Ordinarily, chips are taken off the outside skin of the work where scale is always being cut.

In experimental work, however, carried out on billets or bars, the cut is in clean metal after the first chip has been removed, and the material also is easier to machine as the core of the casting or bar is approached. Therefore, time-tested speed and feed data, as well as dependable reports on total cutter life and life between grinds, are not yet available. The cases cited in this article all refer to cuts taken off the rough diameter of the stock, and can therefore be considered as approaching actual shop conditions.

When steel chips are being produced at high speeds, there is danger of their taking on awkward shapes that are impossible to handle and may even prove dangerous to the operator. Some tests will be described that have been made to see what could be done to produce satisfactory chips in the simplest possible manner. Speed and feed data are given also for the several cases.

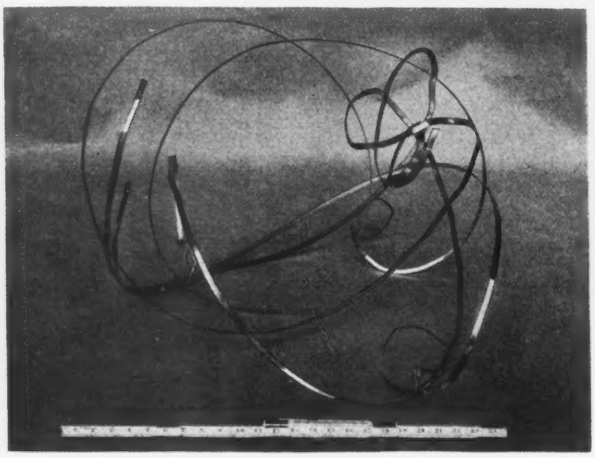
The passing of steel chips over the top surface of cemented tungsten-carbide cutters produces craters in that surface which soon destroy the cutting edge. This is the reason for the failure of tungsten carbide in cutting steel. With cemented tantalum-carbide cutters, this difficulty has apparently been overcome. There is practically no wear on the top of the cutter, all of it being on the side.

This condition is fortunate from a steel-cutting point of view, as it is possible to grind a groove right into the cutter against which the chip will curl into a tightly wound "snake," without the danger of rapid cutter wear, cratering, packing of chip particles, or crumbling of the keen edge. Further, this groove is not affected by the sharpening of the cutter, as a light grind only is necessary on the end and the side of the cutter in order to restore its original condition.

A PROGRESS RECORD IN THE ART OF CUTTING METAL

Fig. 1 shows a chip of awkward shape formed with a tungsten-carbide cutter that had no chip-curler groove, while Fig. 3 shows much better types of chips formed with a tantalum-carbide cutter having a properly ground chip-curler groove on its top surface. Fig. 2 shows a tantalum-carbide (Carboloy No. 77) cutter mounted in a

Fig. 1. Awkward-shaped Chip Formed by a Tungsten-carbide Cutter without Chip-curler



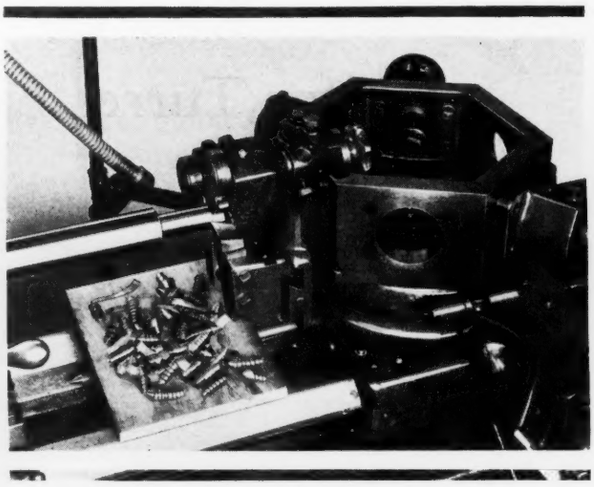


Fig. 2. Tantalum-carbide Cutter Mounted in a Bar Turner on a Hexagon Turret Lathe

bar turner on the hexagon turret. The machine is a standard 2A Warner & Swasey turret lathe running at twice "catalogue" speed. It is thus able to deliver twice the horsepower. The turner also is a standard tool, except that high-duty roll-carriers have been substituted.

The heading illustration shows a chip produced with this combination. The surface speed was 140 feet per minute; the feed, 0.020 inch; and the depth of cut, 1/2 inch. The bars were black stock, 1.10 per cent carbon tool steel, 2 3/4 inches in diameter. Some 30 running feet of bar stock was cut with this cutter without apparently dulling the cutting edge materially. Fig. 4 shows the turned bars from which this chip was produced. The length of the chip snake shown in the heading illustration is 130 feet. This is fairly conclusive evidence that the chip rolled off the cutter with apparent ease.

In shop practice it is desirable, of course, to break up such long snaky chips into shorter lengths, and this can be easily accomplished by mounting an obstruction on the turner on which the snake must snag. In Fig. 3, the chips shown at *A*, *B*, *C*, and *D*, produced on the same turner, were automatically chopped in this manner. The chip at *E* came directly off the cutter in the condition shown—an ideal type to handle.

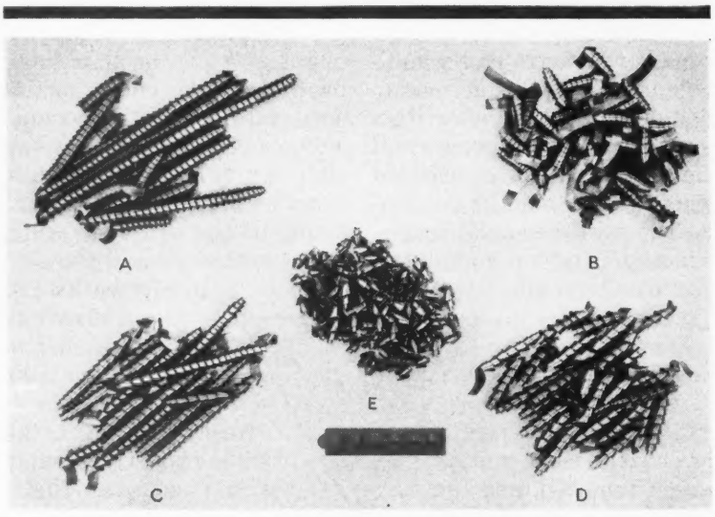


Fig. 3. Chips Produced by a Cutter with a Chip-curler Groove

Below are given the data concerning the chips shown in Fig. 3. The material is cold-rolled steel S A E-X1315; 2 3/8-inch diameter bars are reduced to 1 3/8 inches in diameter, the depth of cut being 1/2 inch. A tantalum-carbide (Carboloy No. 77) tool was used.

Chip *A* resulted from a cutting speed of 380 feet per minute, with a feed of 0.015 inch per revolution.

Chip *B* resulted from a cutting speed of 380 feet per minute, with a feed of 0.020 inch per revolution.

Chip *C* resulted from a cutting speed of 530 feet per minute, with a feed of 0.020 inch per revolution.

Chip *D* resulted from a cutting speed of 380 feet per minute, with a feed of 0.027 inch per revolution.

Chip *E* resulted from a cutting speed of 380 feet per minute, with a feed of 0.027 inch per revolution.

The following experimental test gives an indication of what may be expected from this new cutting material in machining alloy steel:

Work: Ball race (Fig. 5); quantity tested, 12; material, S A E-52100 (a high-carbon chromium steel); weight of twelve forgings, rough, 197 pounds—ma-

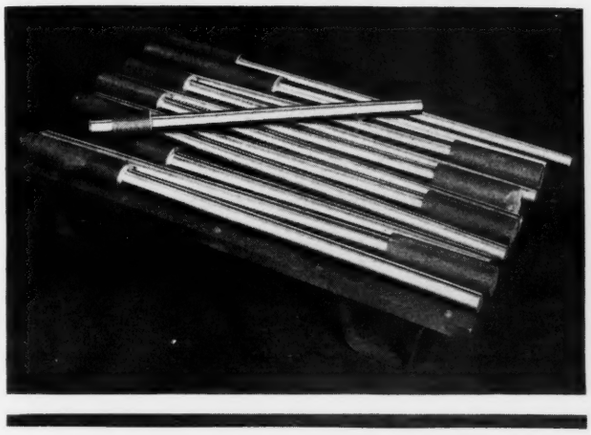
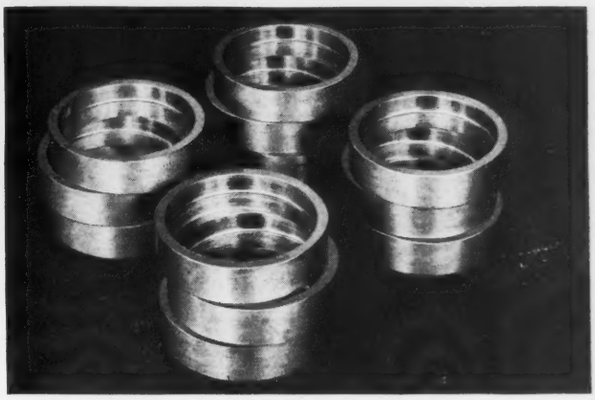


Fig. 4. Bars from which Chips of the Form Shown in the Heading Illustration were Cut

Fig. 5. A High-carbon Chromium-steel Ball Race Machined with Tantalum-carbide Cutters



chined, 123 pounds; material removed, 74 pounds; machine, Warner & Swasey 3A,M-550; cutter, Carboloy No. 77-A tantalum carbide; coolant, Sun Oil Co.'s "Water-Sol-Oil"; cutting speed, 185 feet per minute; cutting feed, 0.020 inch per revolution; and depth of cut, 1/8 to 5/16 inch.

The cutters used were not ground or honed during the run, and they were in fine condition after the test. There was no appreciable wear or cratering on the top surface and slight evidence of wear on the side, a very light grind being sufficient to restore the original condition.

Present Designs of Machine Tools Can be Used

It is apparent from these tests that the use of tantalum-carbide cutters may easily render obsolete much of the speed and feed data now used for cutting steel. The power requirements, of course, will go up almost in direct proportion to the increased number of cubic inches of metal removed in a given time. There is, however, evidence that the unit power factor may be somewhat lower for tantalum-carbide cutters than that used with high-speed steel cutters. To what extent this phenomenon can be laid to a lower coefficient of friction and to conditions of heat is yet to be determined.

The increased power will have to be expressed almost entirely in higher speeds without changing the torque factor materially. Therefore, if a given machine tool has a sufficiently high design factor of safety to warrant speeding up the drive pulley, the increased power can be readily obtained.

Fig. 6 shows cold-rolled steel chips produced on a Warner & Swasey 2A universal turret lathe of standard design, which has been run under the conditions described for months at a time. Timken main spindle bearings, alloy-steel gears, and Timken mountings on all gear-shafts are regularly used. The drive pulley is running at twice the "catalogue" speed with a doubled power rating of $14.2 \times 2 = 28.4$ horsepower at the drive pulley. The actual power consumed in this instance is 33 horsepower at the drive pulley, multi-V belts being used to transmit this power from the motor. The feed was 0.024 inch per revolution and the cutting speed 480 feet per minute. The Carboloy No. 77 cutter performed excellently under these conditions, and the chips came off in the small chunks shown in the cut.

As has been stated before, the data available so far cannot be considered conclusive. On the other hand, it is evident that machine tool equipment on the market at the present time is capable of performing very creditably when used with this new cutting material. Thus, at least one of the questions that are frequently asked by machine tool users has been satisfactorily answered.

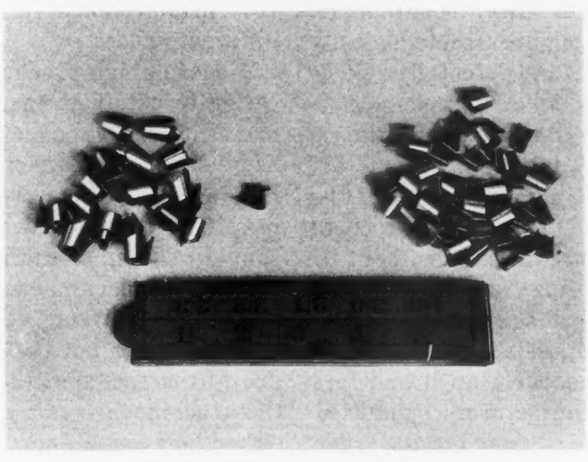


Fig. 6. Steel Chips Produced under Regular Production Conditions

EDITORIAL COMMENT

A PROGRESS RECORD IN THE ART OF CUTTING METAL

In presenting a series of articles on cutting alloys in this number of MACHINERY, the authors of the articles, as well as the editors, are well aware of the fact that our knowledge of the possibilities of the new cutting alloys is still very limited. Much that is accepted as correct practice today may be changed tomorrow. We do not know yet exactly what are the most favorable conditions under which the new tools should be used. We are still experimenting. New discoveries are constantly being made—almost from day to day. Doubtless, while May MACHINERY is on the press and these articles are being printed, new facts will be discovered in some shop or laboratory that will change certain of the conclusions previously reached. Nothing is ever complete or final.

Industry Cannot Wait for All Experiments to be Completed

The mechanical industries, however, must work with the knowledge at hand at any given moment. They cannot afford to wait until everything is known about a certain process or method; hence, the progress of every mechanical art should be recorded from time to time, even though ultimate perfection in tools and methods has not been reached. It is such a progress record that is presented in this number.

The buying of engineering equipment is rather an unemotional matter-of-fact business. Sales are not generally made by the methods utilized in many other lines of business. The most fluent talker is not necessarily the most successful salesman of engineering products. Just the same, there is merit in being able to set forth selling arguments logically and forcefully. To be able to explain thoroughly the engineering features of the equipment that he sells is an asset to any salesman; he cannot expect success without it.

It Pays to Explain Mechanical Features Thoroughly

Some time ago the works manager of an automobile plant told us that he had asked two machine manufacturers to submit proposals for doing a certain operation faster and cheaper than it had formerly been done. Both manufacturers submitted blueprints and estimates. One of them got the order and the equipment was installed.

Later, the unsuccessful manufacturer called at the plant, saw the competing equipment in operation, and asked why his machine had not been bought instead; it would have given much better production. This led to a re-examination of the drawings originally submitted. The works manager confessed that the methods submitted by the unsuccessful manufacturer, which were rather new and unusual, had not been fully appreciated by him. They had not been thoroughly explained; otherwise his decision might have been different. It pays to explain clearly.

Although a great many magazine articles and not a few books have been published showing the part that the machine has played in raising the well-being and the standard of living of all industrial nations, it is not unusual to hear men who are considered leaders in their respective fields voice the sentiment that the machine is the chief reason for industrial stagnation and unemployment.

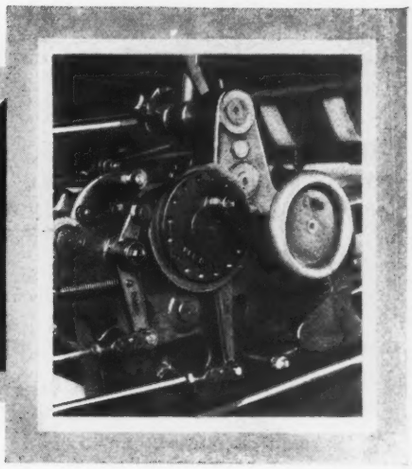
In the machine, these men find a convenient scapegoat for the economic ills that have overtaken the industrial nations. It is by blaming the machine that the politician, the financier, the labor leader, and the militarist hope to escape the blame that might otherwise be laid at their door.

Why Don't We Stop Blaming the Machine for Our Troubles?

It is time that all who are engaged in the machinery industries, and who have furthered the progress and increased the material comforts of mankind by their work, should refuse to accept the responsibility for difficulties that are due to entirely different causes.

Modern high-production machinery makes it easier to obtain the material comforts of life. It makes it possible to place within the reach of everybody all the comforts and many of the luxuries that half a century ago were available only to those most favorably situated. In as far as the available supply of food, clothing, and shelter is concerned, the modern machine has made it possible to abolish involuntary poverty. That there still is poverty and distress is not the fault of the machine. It is due to the fact that the benefits made possible by the machine are not made generally available—either because of lack of intelligence, or perhaps, lack of public spirit and good will.

Ingenious Mechanical Movements



Unique Lever Motion Obtained by Toggle Link and Cams

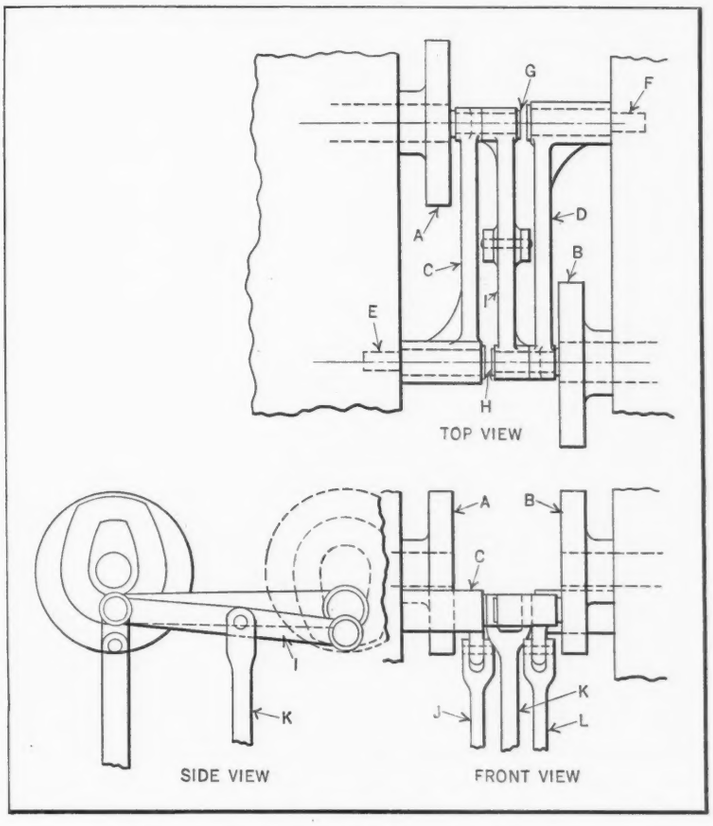
By R. H. KASPER

The lever-motion mechanism shown in the accompanying illustration is used on a wire-forming machine to obtain the motions described in the following: Two rods *J* and *L* are given a reciprocating motion, the timing relationship of which must be adjustable. Each of these rods must pass through a complete cycle of motions for each revolution of the drive shaft, although they never operate simultaneously. A third rod *K* is given a similar reciprocating motion of lesser magnitude. The latter rod, however, must pass through two complete cycles for each revolution of the drive shaft, each cycle being performed simultaneously with the cycle of the other two rods. Any change in the timing relationship between the first two rods must be automatically transmitted to the third rod.

The cams *A* and *B* operate at the same speed, and impart the required oscillating movements to the levers *C* and *D*. Cams *A* and *B*, although similar in outline, are set with their lobes approximately 180 degrees apart, and each cam can be adjusted slightly in its timing relationship with the other cam. Lever *C* fulcrums on stud *E*, while lever *D* fulcrums on stud *F*. Studs *E* and *F* are so located that levers *C* and *D* are in a horizontal position when their oscillating ends are held at their lowest points by the cams.

Lever *I* is supported on studs *G* and *H*, carried on the oscillating ends of levers *C* and *D*, respectively. Rods *J*, *K*, and *L* are attached to levers *C*, *I*, and *D*, respectively, and serve to transmit the motion to the required points. As lever *C* is oscillated by cam *A*, lever *I* is given a similar motion, being pivoted on stud *H*, which is held in a fixed position by cam *B*.

After lever *C* has passed through its cycle and come to rest, lever *I* is given a similar movement at the opposite end by cam *B* through lever *D*. As the movement of lever *I* is produced entirely by levers *C* and *D*, it must always operate in exact synchronism with these levers, regardless of the adjustment of cams *A* and *B*. The front view shows the levers at rest. The side view shows rod *K* moved to its lowest point by the action of lever *I*.



Mechanism for Transmitting Motion to Three Levers of a Wire-bending Machine

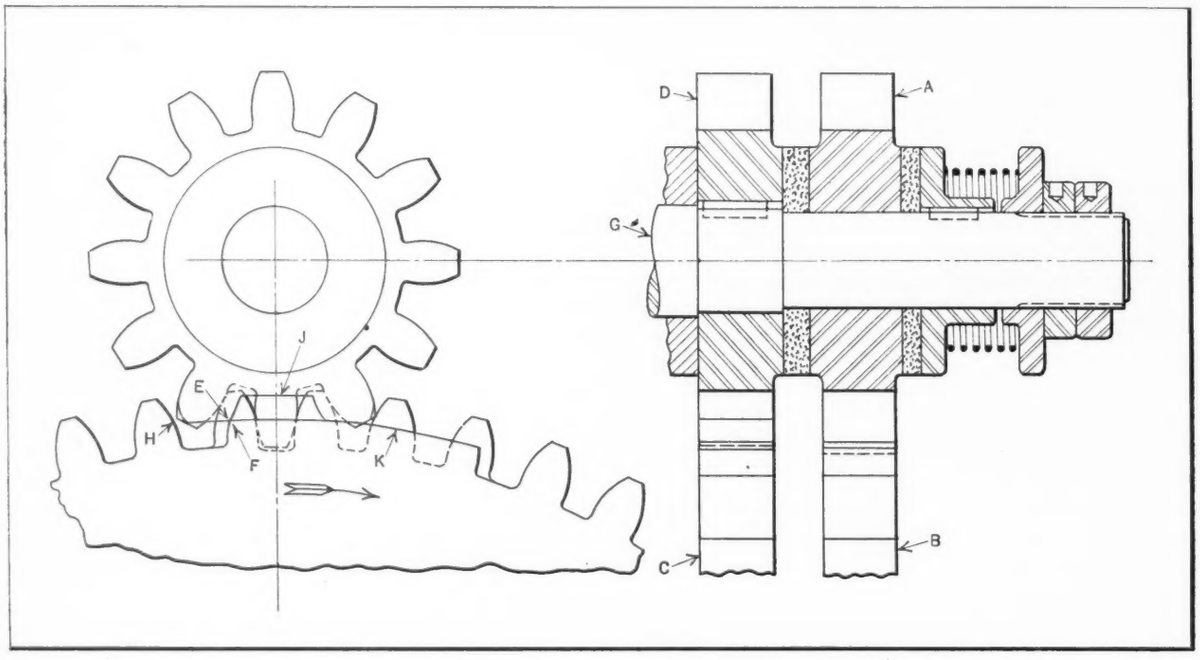
Shock-Reducing Arrangement for Intermittent Gearing

By J. E. FENNO

One of the objections to the usual intermittent gear train when used for rapid indexing is the impact of the teeth at the beginning of each movement. At lower speeds this impact is negligible and can be ignored, but for higher speeds, the operation of the mechanism is noisy and the leading teeth are either soon battered out of shape or broken. To overcome this condition in an intermittent gear train operating an automatic hopper, a second set of gears was incorporated, as shown in the illustration. These gears *A* and *B* serve to start the driven shaft *G* rotating with very little shock just before the leading teeth in the intermittent gears come into contact. Another advantage is that the starting torque is borne by a number of teeth in gears *A* and *B* instead of by two teeth only, as in the usual type of intermittent gear train, thus reducing tooth wear.

The intermittent gears, which are keyed to their respective shafts, are indicated at *D* and *C*. The second set of gears is also mounted on these shafts. Gear *A*, however, is free to turn on its shaft, while gear *B* is keyed to the lower shaft (not shown). Both the gears *A* and *B* have teeth all around their circumference, the tooth pitch and pitch diameters being the same as in the corresponding gears *D* and *C*. It will be noted that gear *A* is confined between friction washers, which tend to transmit a turning movement to the driven shaft. The pressure of the washers against the gear can be varied by adjusting the lock-nuts, which changes the tension of the coil spring. With this arrangement, the pitch-line speed of gear *A* and of gear *D* (when in motion) are the same.

In operation, the driving gears *C* and *B* rotate in the direction of the arrow. With the gears in the position shown, it is obvious that unless special provision is made, the entire force of impact in starting the indexing movement will be at point *H*. In the present design, however, part of the force is divided between several teeth in gears *A* and *B*. As soon as point *F* has passed point *E*, gear *D* begins to rotate, through the action of the friction drive, before the leading teeth in gears *D* and *C* come into contact. This rotation is started with practically no shock, and continues until the teeth of both intermittent gears are properly meshed.



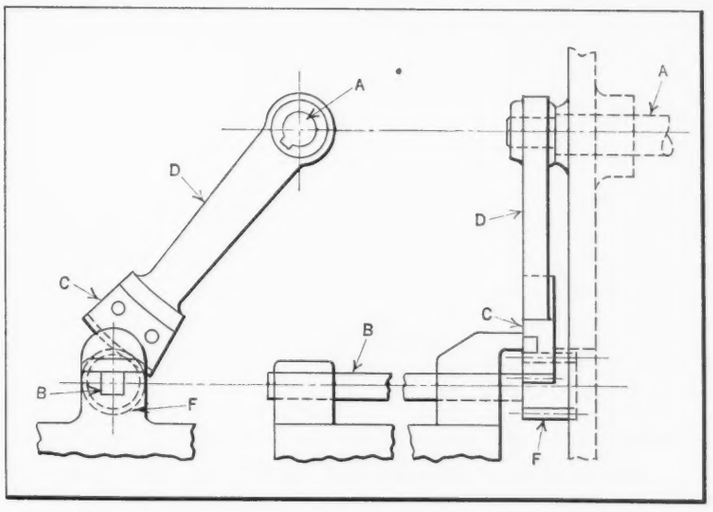
Intermittent Gear Train in which Impact Shocks are Reduced by a Friction Gear Drive that Starts Each Indexing Movement

Some experimenting may be required before the check-nuts are adjusted so that the tension on the coil spring is sufficient to balance the normal load imposed on the mechanism. The clearance *J* in gear *D* also deserves some mention. By removing the metal at this point, a longer dwelling surface *K* is obtained, thus reducing the time, at the beginning and end of each dwell, in which the gears are in their unlocked positions. It should be understood that this mechanism is suitable for light loads only. If the load is too great, the wear on the dwelling surfaces of the intermittent gears will be excessive due to the torque produced by the friction drive during each dwell. Rapid wear, however, can be prevented by the use of hardened inserts in the dwelling surfaces.

Making Helical Gear Segments Serve as Cams

By H. E. KITCHEN

A novel and what proved to be a very practical application of helical gear segments and pinions is described here. Referring to the accompanying illustration, shaft *A* has an intermittent rocking movement, which is alternately clockwise and counter-clockwise. The range of these movements is through an angle of about 5 degrees. This rocking lever is required to impart an endwise movement to the square bar or shaft *B*. For this purpose, a segment of a single helical gear *C* is attached to lever *D*, and a helical pinion *F* of equal angle, but of opposite hand, is fitted to the shaft *B*. Shaft *B*, being square, cannot rotate, and is therefore forced to move endwise.



Helical Gear Segment and Pinion Used as Cams to Produce Longitudinal Reciprocation from Rocking Movement

The helical segments and the helical pinions used in this construction were much less expensive than cams. A complete ring gear furnishes enough segments for several machines. By making the number of teeth in the pinion a multiple of 4 and cutting four keyways in the shaft hole, it is possible to bring new teeth of the pinion into the working position when wear takes place by changing the position of the gear on the shaft. When the square shaft *B* can be made to serve equally well in any position, only one keyway is necessary, as the shaft and gear can be keyed together as a solid unit and relocated in one of four positions to bring unworn teeth into contact with the segment *C*. The segment *C* is supported on each side, a roller support being used when necessary to reduce the friction load. Gears with teeth having a helix angle of 45 degrees or more give satisfactory performance in this kind of service.

* * *

A tank car for handling granular materials as conveniently and efficiently as standard tank cars now handle liquids has been developed by the General American Tank Car Corporation. The new tank car is known by the trade name "Dry-Flo." It has been designed for such products as cement, lime, silica sands, flour, sulphur, cleaning compounds, etc. Its practical value has been fully demonstrated by thousands of miles of trial runs.

A Constructive Method of Helping the Unemployed

The Department of Commerce, Washington, D. C., has published a brief report on home vegetable gardens planned with the assistance of industrial firms to help their unemployed and part-time workers to support their families at the present time. The report shows that last year many machinery-building concerns aided in these garden projects, and thousands of families were able to grow their own foods to supply their immediate needs and to preserve a surplus for winter use.

Similar programs are being planned by many industrial concerns for the present summer. The International Harvester Co., for example, aided in establishing large garden projects covering 300 acres at its branch plants. Another machinery company mentioned in the report is the Whitin Machine Works of Whitinsville, Mass., where the employes planted, last year, 185 vegetable gardens. The National Cash Register Co., the Dayton Malleable Iron Co., the American Car & Foundry Co., and the Warner Gear Co., are also among the firms mentioned who furthered home garden developments. This is one constructive method of helping the unemployed.

* * *

Tests on Riveted Lap Joints

Report No. 2283, published by the Testing Laboratories of Columbia University, New York, relates to comparative tests made with Dardelet rivet bolts and hot-driven rivets. These tests indicate that lap joints assembled with single Dardelet rivet bolts are stiffer and stronger in tension than similar joints connected with structural hot-driven field rivets. The tests indicate further that the Dardelet rivet-bolt connections show no pronounced slip, but rather a gradually increasing rate of displacement with applied load, which may be due either to the high frictional resistance resulting from the tension produced by the Dardelet-threaded nut or to the intimate contact of the driven bolt with the bolt holes, or both. The Dardelet rivet bolts are made by the Dardelet Threadlock Corporation, 120 Broadway, New York City.

Modern High-Speed Steels and Their Characteristics

Composition, Heat-Treatment and Application of the Various Types of High-Speed Steel in Most Common Use

By J. P. GILL, Metallurgist, Vanadium-Alloys Steel Co., Latrobe, Pa.

THREE general types of high-speed steel of proved merit are in common use in this country today. These types may be designated as (1) the 18 per cent tungsten, 4 per cent chromium, 1 per cent vanadium type; (2) the 14 per cent tungsten, 4 per cent chromium, 2 per cent vanadium type; (3) the 18-4-1 per cent type plus a variable percentage of cobalt. The analyses of a number of different high-speed steels that are being marketed at the present time by representative American manufacturers are given in the accompanying table.

Steel of the 18-4-1 type, identified as No. 1 in the table, is by far the most generally used high-speed steel. In fact, it is a steel of this analysis to which one generally refers in speaking of high-speed steel. Probably from 80 to 90 per cent of the high-speed steel used in America today is of this type. The so-called 14-4-2 type, identified as No. 6 in the table, is used much less today than a few years ago, while the cobalt types—Nos. 8, 9, and 10—are for special and restricted use, but are very efficient and valuable when properly applied.

Analyses of High-Speed Steels

Identification Number	Carbon, Per Cent	Tungsten, Per Cent	Chromium, Per Cent	Vanadium, Per Cent	Cobalt, Per Cent	Molybdenum, Per Cent
1*	0.55 to 0.75	18.00	4.00	1.00	.....	....
2	0.55 to 0.75	18.00	4.25	0.70	.....	....
3	0.55 to 0.75	21.00	4.00	1.15	.....	....
4	0.65 to 0.80	18.00	4.00	2.00	.....	1.00
5	0.55 to 0.75	17.00	3.25	1.00	.....	....
6	0.55 to 0.75	14.00	4.25	1.65	.....	....
7	0.55 to 0.75	14.00	4.50	2.10	.....	....
8	0.65 to 0.80	17.50	4.00	1.00	4.00	....
9	0.65 to 0.80	17.50	4.00	1.75	7.00	1.00
10	0.65 to 0.80	17.50	4.00	1.75	11.00	1.00

*This high-speed steel also contains 0.25 per cent silicon, 0.25 per cent manganese, 0.015 per cent sulphur, and 0.020 per cent phosphorus.

The carbon content is of great importance in high-speed steel, since, with the tungsten and chromium content remaining constant, the hardness and toughness of the steel vary in direct proportion to the carbon content. A carbon content ranging from 0.67 to 0.72 per cent is almost always used, as this range seems to give the best combination of hardness, cutting ability, and toughness.

If we lower the carbon content, we increase the toughness noticeably. This may be very important for certain types of blanking dies, chasers, etc. On the other hand, if the carbon content is increased, the steel will have somewhat better cutting efficiency, but will be more brittle. For certain classes of tools, such as lathe, shaper, and planer tools, the higher carbon content can be used to better advantage. A great many high-speed steel tools, such as milling cutters, hobs, taps, broaches, drills, reamers, etc., have a carbon range of 0.67 to 0.72 per cent.

The silicon content of high-speed steel is not particularly important, as long as it is held within reasonable limits. It is usually under 0.35 per cent, but many grades of high-speed steel have been made with a silicon content as high as 1.00 per cent and no detrimental results have been noticed. The manganese content, however, is quite important, since the manganese makes the steel more sensitive to treatment and a high manganese content is likely to cause excessive breakage in hardening. The manganese, therefore, should be kept under 0.35 per cent.

Sulphur and phosphorus are given very little consideration today, since the electric basic furnace and the availability of low-phosphorus scrap make it comparatively simple to keep the sulphur and phosphorus content under a maximum of 0.03 per cent. As long as the sulphur and phosphorus are kept under 0.03 per cent, there is little variation in the physical properties resulting from a variation in these elements. Originally, high-speed steel, which was, of course, made in the crucible furnace, often had a sulphur content as high as 0.045 per cent, and a phosphorus content as high as 0.04 per cent.

Balance between Cutting Ability and Toughness Determines Tungsten Content

Tungsten is, of course, the key metal of high-speed steel, and the very nature of high-speed steel is dependent upon this element. If the tungsten content is decreased to less than 18 per cent, toughness is considerably increased, with a sacrifice of cutting ability. If the tungsten content is increased to over 18 per cent, cutting ability is gained at a sacrifice of toughness. Therefore, the 18-4-1 type high-speed steel gives the best balance between cutting ability and toughness.

Changes in the chromium content have much the same effect as changes in the tungsten content. If

the chromium content is decreased to under 4 per cent, the steel does not harden as readily, but seems to be somewhat tougher. Some cutting ability is sacrificed with a lower chromium content. If the chromium content is increased materially over 4 per cent, the steel hardens with greater ease. It also has somewhat better cutting ability, but is noticeably more brittle.

Factors Controlling Vanadium Content

The element vanadium adds increased cutting efficiency to high-speed steel, probably due to the formation of vanadium carbides, which are very stable at high temperatures, and also to the fact that vanadium apparently gives a better distribution of the segregate. The cutting efficiency of high-speed steel increases with an increase in the vanadium content.

Vanadium, however, is quite an expensive metal, costing about $3.25 a pound. Therefore, as we increase the vanadium content we are materially adding to the cost of the steel. It appears probable that for each ten points of vanadium under 1 per cent, we obtain more increased efficiency than for each ten points of vanadium over 1 per cent. Therefore, about 1 per cent vanadium seems to give the most for the money, although a steel of the 18 per cent tungsten type containing 2 per cent vanadium does have a better cutting efficiency than one with 1 per cent vanadium.

In cutting ability, the 14-4-2 type of high-speed steel compares favorably with the 18-4-1 type, and some authorities have claimed that it is even more efficient when used for hogging cuts. The 14 per cent tungsten type, however, is noticeably more sensitive to heat-treatment and grain growth, due to its lower tungsten content. Therefore, tools made from this type of steel do not give such uniform results as tools made with the higher tungsten content. It was used to a considerable extent by a number of different tool manufacturers during the World War, and practically all the large tool manufacturers have experimented with it. However, the writer knows of no large tool manufacturer who uses this grade of steel today as standard for the regular run of high-speed steel tools.

Cobalt Increases Cutting Efficiency

The element cobalt was introduced into high-speed steel in about 1912, and it was found to increase noticeably the cutting efficiency of high-speed steel, particularly when applied to hard materials, cast iron, etc. The cutting efficiency of the steel seems to increase with the cobalt content, and steels are now marketed with a cobalt content of from 4 to 12 per cent. The addition of this material naturally affects the price of the high-speed steel considerably.

Developments in the Use of Molybdenum

The element molybdenum seems to have about the same effect on high-speed steel as tungsten, so far as cutting ability is concerned, but only about one-half as much molybdenum as tungsten is necessary to obtain the same effect. Molybdenum tends to volatilize during the heating operations, and therefore any large percentage of molybdenum—that is, over about 2.50 per cent—leads to manufacturing and heat-treating difficulties.

The Watertown Arsenal has recently developed a molybdenum steel containing 9 per cent molybdenum and no tungsten. This steel, however, must be covered with a flux, such as borax, during all the heating operations to prevent it from being attacked by the air. The 9 per cent molybdenum steel easily equals in cutting ability the 18 per cent tungsten steel, but the difficulties in its manufacture and heat-treatment will probably prevent it from being generally used. Nevertheless, it may prove a valuable material in the event that our supply of tungsten is curtailed. Molybdenum in high-speed steel, of course, is not new, dating back to before 1902.

Applications and Physical Characteristics of High-Speed Steel

Since the 18 per cent tungsten, 4 per cent chromium, 1 per cent vanadium type of high-speed steel represents some 80 or 90 per cent of the total, we will consider only this type in our discussion of properties and heat-treatment. High-speed steel, as its name indicates, is essentially a cutting steel, and can be used at high speeds without substantial loss of hardness. It will continue to cut readily when the cutting edge of the tool has become heated to a visible red heat. It is therefore used chiefly for lathe, planer, and shaper tools, drills and reamers, milling cutters, hobs, taps, chasers, and similar tools.

For many years, high-speed steel was applied chiefly to those operations in which considerable heat was generated. High-speed steel, however, in the hardened condition has from five to eight times the wear resistance of a straight 1 per cent hardened carbon tool steel at room temperature. This characteristic was not early recognized, or if recognized, was not applied. Since 1918, however, high-speed steel has been used for many operations where the friction is insufficient to cause the tool to become hot or even warm. Such applications include blanking dies, broaches, certain types of shear blades, etc.

In the hardened condition in which high-speed steel must be used, it is quite brittle, as compared to most other types of tool steels. It has a low impact value, and in the design, as well as in the heat-treatment of tools, this characteristic brittleness should always be taken into consideration. Its wearing qualities have already been mentioned. At the higher temperatures, it will show greater strength than almost any other steel of like content. This property is not made use of, however, because the steel scales very badly at high temperatures. Its chief physical characteristic is its ability to withstand tempering or heating to a temperature of approximately 1100 degrees F. after it is hard-

ened without loss of hardness. It is this characteristic, of course, that makes it extremely valuable as a cutting material.

Main Factors to be Considered in the Heat-Treatment of High-Speed Steel

About the year 1902, Taylor and White outlined the basic treatment for high-speed steel in their famous paper on the "Art of Cutting Metals." The treatment outlined consisted essentially of heating the steel quickly to as high a temperature as possible without burning, then cooling quickly, and reheating. These instructions sound quite simple and, when applied to rough lathe and planer tools, are comparatively easy to follow. To harden properly fine-edged tools, such as taps or chasers that do not admit of grinding afterward and that must have a file-hard surface without scaling, pitting, blistering, or decarburization of the fine edges requires considerable equipment, care, and technique.

The American Society for Steel Treating gives a good outline for the heat-treatment of high-speed steel in its handbook. As this book is available to most readers, the outline will not be repeated. In view of the fact that it is always advisable to heat the steel as quickly as possible, preheating is essential. This may consist of a double or a single preheat. If double preheating is used, the lower-temperature furnace is usually held in the vicinity of 1000 degrees F., at which temperature the steel may remain for a considerable length of time without detriment.

The higher preheat is usually at a temperature of about 1550 degrees F. The steel is usually held in the 1550-degree F. preheating furnace only until thoroughly heated, and is then transferred to the high-heat furnace kept at a temperature of from 2250 to 2375 degrees F., depending upon the type of tool, most tools being heated at the higher temperature. If the steel is held too long in the preheating furnace, scaling may result, which would cause decarburization or a soft surface in the finished tool. The length of time the steel is in the high-heat furnace is very important, as grain growth is quite rapid at a temperature of 2350 degrees F. Since we usually wish to keep the steel as tough as possible, it is advisable that the grain growth be held at a minimum.

Difference in Hardness Due to Oil or Air Quenching is Very Slight

After the steel has been heated to the proper temperature for hardening, it is either oil-quenched or air-quenched, oil being the medium usually employed. Any variation in the hardness of the steel due to a difference in the quenching medium is very small—usually not over about one point in the Rockwell hardness scale in the case of small tools, nor over two points for large tools. For large complicated tools, where danger of cracking is fairly great, air-quenching is often advantageous. Quenching in air, however, causes the formation of a fairly heavy scale, which should be removed before the tool is used. In some instances, the scale may be so troublesome that oil-quenching is necessary.

The temperature of the steel, on cooling, must drop below about 500 or 600 degrees F.—it must be definitely under the lower critical cooling temperature. If the steel is not cooled to a temperature below this critical point, it will not temper when heated to the proper temperature. In other words, unless the steel is cooled sufficiently, low reheating will not change the structure.

On the other hand, it is best not to cool the tools to too low a temperature or there may be danger of breakage. The steel should be reheated slowly for tempering, a temperature of about 1050 degrees F. being best. The steel should be held at the tempering temperature for from one to two hours, depending on the size. Holding the tool a longer time at the tempering temperature will result in some increase in toughness, with a slight sacrifice of hardness.

The Relation of Toughness to Hardness

It appears that when greater toughness is desirable, it is just as well to use a somewhat higher drawing temperature and a shorter length of time. In high-speed steel the secondary hardness which results from drawing occurs at a higher temperature than in other types of steels. There is an actual secondary hardness in even carbon tool steels, but it occurs at very low temperatures. The intensity of the secondary hardness depends on the initial hardness of the steel. It is unfortunate that the toughness of the steel, on tempering, is inversely proportional to the hardness. The steel is probably toughest when drawn at a temperature of 900 degrees F., and most brittle when drawn at a temperature of 1100 degrees F., which is almost the point at which maximum secondary hardness is obtained.

The 18 per cent tungsten type steel to which the preceding discussion wholly applies is the easiest of the types to harden. The 14 per cent tungsten type is very sensitive to grain growth at high temperatures; therefore, it is looked upon as a difficult steel to treat. The cobalt type of high-speed steel is quite susceptible to decarburization during the hardening operation—so much so that it is usually considered advisable to use cobalt steel only for tools that can be readily ground after hardening.

The present article will give production men in the machinery industries a comprehensive idea of the different grades of high-speed steel available and their uses.

Economic Factors Affecting the Use of Carbide-Tipped Milling Cutters

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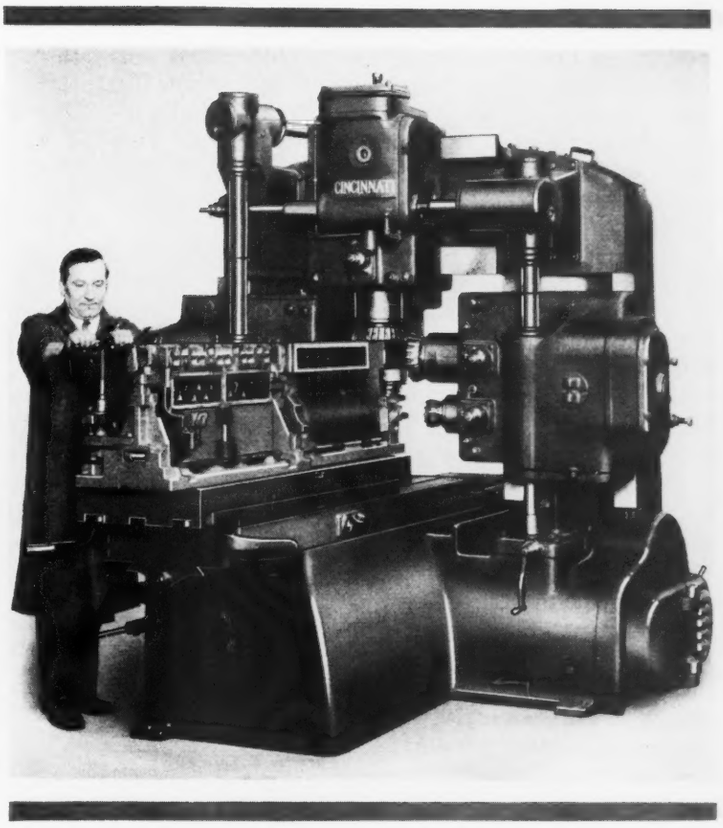


Fig. 1. Milling Top, Large Side Pad, Manifold Face, Tappet-cover Face, and Right and Left Support Pads of Cylinder Blocks with Tungsten-carbide Tipped Cutters

WHILE the great majority of applications of tungsten- and tantalum-carbide tipped cutting tools have been in turning, boring, and planing operations, the use of these materials for blades of milling cutters has made considerable progress. The chief advantages resulting from their use are fairly well known and apply to milling as well as to the other operations mentioned. These are the possibility of using higher speeds and feeds, increased tool life, and the cutting of hitherto unmachineable materials.

In addition, there are some advantages that are more or less peculiar to milling. These are greater accuracy and better finish, and a minimum distortion of the work piece resulting from a reduced chip per tooth or feed per revolution. There is also a chance to reduce the amount of stock allowed on castings for finish, because of the ability of the new tools to cut the scale. This makes it possible to combine roughing and finishing cuts and permits faster feeds without the breaking out of the edges of castings.

Remarkable savings have been made in some applications, several of which have already been referred to in the technical press. On the other hand, there doubtless have been some disappointments due to improper applications, made without sufficient knowledge of the characteristics of the new tool material. The information given in the present article is intended to aid in determining the feasibility of applying tungsten and tantalum carbide to specific milling operations.

In the last analysis, the total cost of the operation is the deciding factor. The total cost must take into consideration all the elements of expense involved, as, for example, direct and indirect labor, amortization of the cost of milling cutters, cost of the fixtures, machine rate, cost of maintaining the cutters, cost of power, etc.

A PROGRESS RECORD IN THE ART OF CUTTING METAL

When and When Not to Use Carbide-Tipped Milling Cutters

Primarily, of course, the decision must be made as to whether the cemented carbide material can be applied at all. This depends on a number of factors. So far, for instance, it appears impracticable to produce form cutters. Almost all the milling cutters produced up to the present time have been of the face mill or shell end-mill type, where the surface to be machined is at right angles to the axis of the cutter. This permits the use of a relatively small amount of the expensive carbide. The main weakness of the carbides is in resistance to shock. Cutters of the face mill type generally have several teeth in contact with the work at one time. This dampens the impact of the tooth against the work.

On the other hand, cutters that produce surfaces parallel to the axis, require, of necessity, considerably more carbide, as the cutting edges must be as long as the width of the cut. On this type of cutters the impact of the tooth against the work is much greater. This makes carbide teeth less suitable.

As a general rule, unless the operation can be performed by the face mill type of cutter, it is best not to consider the carbide material at present. By face mill type of cutter we mean a cutter that produces a surface at right angles to its axis. This includes face mills, shell end-mills, spiral end-mills, and side-mills, whether the blades are removable or are brazed in place.

Another factor to be considered is the material to be machined. So far, tantalum-carbide cutters have not been particularly successful in milling steel, especially the softer grades. On the other hand, tungsten carbide has shown remarkable results in milling cast iron, aluminum, brass, bronze, Bakelite, and other non-ferrous materials. It has given especially good results in milling hard cast iron.

On the job shown in Fig. 2—a Nash cylinder block—the time to produce one piece was not changed when tungsten-carbide tipped cutters were applied, but the number of pieces produced between cutter sharpenings was increased from 15 to 600 for the 9 1/2-inch cutter and from 9 to 2000 in the case of the 3 1/4-inch cutter.

The manufacturers of tungsten and tantalum carbide are bending every effort to produce materials consistently capable of similar results on steel, and will no doubt succeed. However, at present, it is best not to definitely recommend the new tool materials for steel unless extensive experiments are made under the exact conditions of operation.

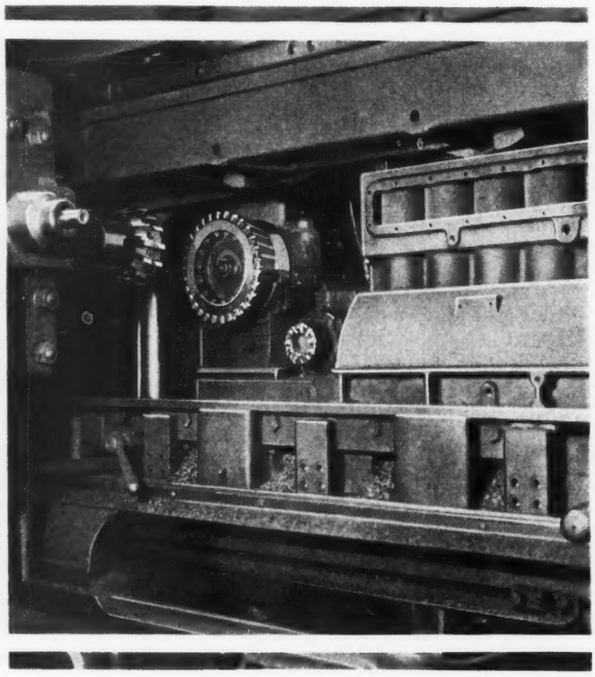


Fig. 2. Milling a Nash Cylinder Block with Tungsten-carbide Cutters Gave Great Increase in Production between Cutter Sharpenings

Another factor to be considered is the production required and the method used to obtain it. More and more shops are being operated on the line-production scheme, where a machine is set up to do one particular operation on one specific part. Frequently each operator attends to more than one machine and is paid only for loading. In such cases, if one machine will produce the required number of pieces without the use of carbide cutters, and at the same time give a satisfactory finish and an economical cutter life, it is questionable if enough could be gained to warrant the higher cost of carbide tools. On the other hand, the use of carbide may so increase the production obtainable from one machine that a second machine can be dispensed with.

A striking example of increased production obtainable with tungsten carbide may be cited from the experience of a prominent motor manufacturer. The three milling machines shown in Figs. 1, 3, and 4 were formerly tooled to produce nine cylinder blocks per hour—all that was required at the time. Later it was necessary to produce more blocks. Additional equipment would normally have been required, but by speeding up the spindles and using tungsten-carbide cutters, the production was increased to eighteen pieces per hour. (Many features of the machines shown in these illustrations are protected by United States and foreign patents.)

Frequently, in a line-production scheme, there is no reduction in the time per piece, but the extra cost of the carbide cutters is more than offset by other savings. The Nash cylinder block previously referred to represents such a case. Another manufacturer substituted tungsten-carbide cutters for high-speed steel on the operation of milling an aluminum crankcase with a 12-inch face mill. Without changing the speed or the feed, the life between grinds was increased from one sharpening every three days to one every five months.

Quite frequently a milling machine is tooled up with two fixtures, so that the operator removes and replaces one piece while the other is being machined. If the fixture is made to be operated as rapidly as possible and the handling of the piece is still the limiting factor, there is nothing to be gained by the decrease in cutting time made possible by the faster cutting alloys.

However, when the cutting time with conventional cutters is the limiting factor, it may be possible by the use of carbide cutters to so reduce the cutting time as to permit the loading and cutting both to be done in less time than that taken by high-speed steel cutters, thus saving the cost of a second fixture. This cost is usually greater than the difference in cost between a high-speed steel and a carbide cutter.

Another factor to be considered is the finish required on the work and its effect on production. Tungsten- and tantalum-carbide cutters run at a much higher cutting speed and at a lower feed per revolution than high-speed steel cutters. They pro-

duce less distortion of the work, have less tendency to break the edges of castings, and consequently are frequently capable of producing, in one cut, at a considerable saving, the finish that otherwise would require two cuts. Where formerly designers had to leave a considerable amount for finish on castings to permit high-speed steel cutters to get under the scale, they can now reduce the stock to be removed to a minimum and thereby save on material costs, because the carbide blades easily cut the harder scale without difficulty.

However, when there is a great amount of stock to be removed, high-speed steel cutters are still first

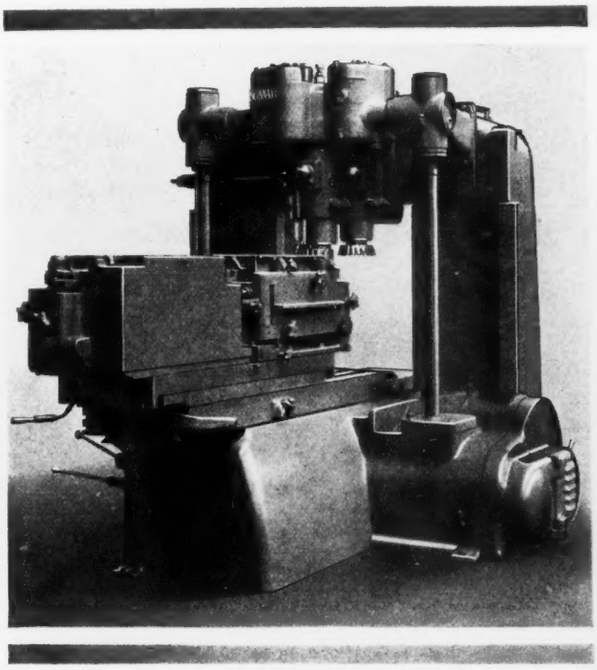


Fig. 3. Rough-milling Oil-pan Face and Bearing Lock of Cylinder Block with Tungsten-carbide Cutters in an Automotive Plant

choice on account of their great strength. The strength of the carbide materials is being improved from time to time by the makers and may soon reach a point where they can be used for heavy roughing.

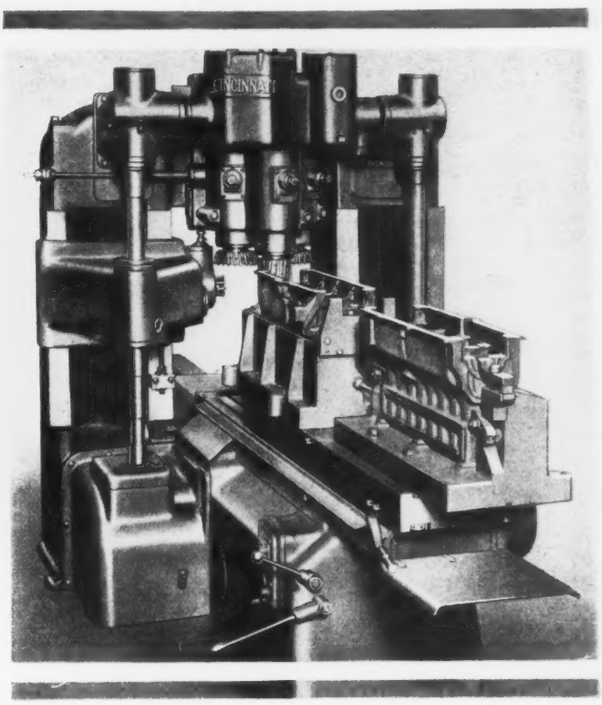
Another factor to be considered is found in the work itself. Tungsten- and tantalum-carbide tools are susceptible to shock and do not perform well on operations where there is considerable vibration or chatter. If the work is of such a nature that it cannot be rigidly supported, or requires a flimsy drive to the cutter, the carbide cutters will not prove satisfactory or economical.

What Type of Machine to Use for Tungsten- and Tantalum-Carbide Milling

Still another factor to be considered is the milling machine on which the work is to be done. Three things are important—the power available, the rigidity of the machine, and the speed and feed range. Most milling machines built in the last five years are normally capable of conveying their rated horsepower to a face mill type of cutter without showing any lack of rigidity harmful to the use of carbide cutters. Older model machines will usually prove unsatisfactory in this respect.

The spindle speeds required may be determined from the cutting speed that can be applied to the material being cut. For cast iron and malleable iron the best practice seems to be from 160 to 250 surface feet per minute; for aluminum and yellow brass, 800 to 1000 surface feet per minute. The

Fig. 4. Finish-milling Oil-pan Face, Bearing Lock, and Pump Pad of Cylinder Blocks with Tungsten-carbide Tipped Cutters



feed range required can be readily calculated from the power of the machine or from the chip per tooth, or from both.

If after analyzing the job to be done from the standpoint of the factors outlined in the preceding paragraphs, it appears that tungsten or tantalum carbide can be applied successfully, the economics of the operation must be taken into account. This means a calculation of the cost of the operation with and without the use of carbide. The saving in its favor must be balanced against its first cost and the expected life between grinds.

Analyzing Milling Operations

In the examples given in the accompanying table and in Figs. 5 to 12, which are from a recently tooled-up automobile production line, the reasons for the choice of the various cutter-blade materials

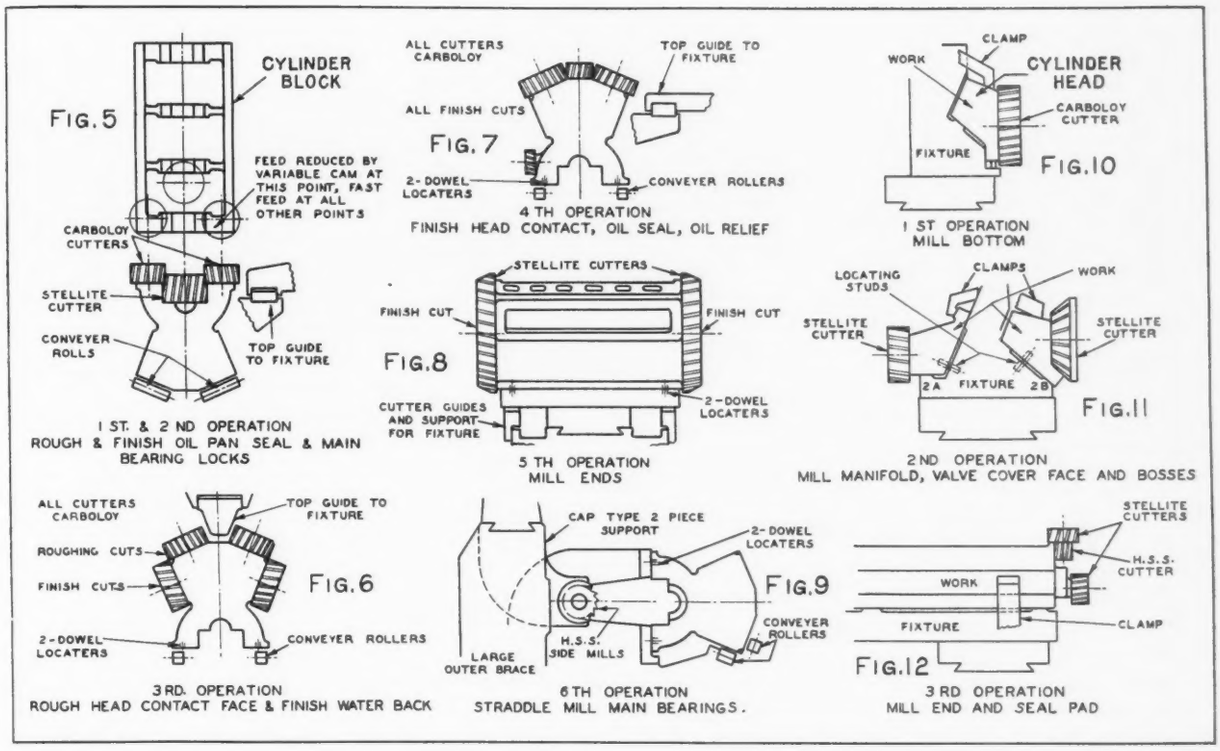
were carefully analyzed. This production line was laid out to provide the minimum cost per piece for a definite production schedule and affords a typical example of the analysis to be made. The figure numbers in the table correspond to the diagrams, making reference convenient.

Fig. 5—The Stellite cutter mills a slot 3 1/4 inches deep by 6 3/8 inches wide, removing from 1/8 to 3/16 inch of metal. This slot is 2 1/2 inches long. The machine is equipped with a variable hydraulic table feed, and the feed is slowed down during the passage of the Stellite cutter through the slot.

Tungsten carbide was used to get high production and longer cutter life; J-Stellite was used for the slotting operation because of longer axial con-

Milling Operations Performed on Cylinder Blocks and Heads of a Twelve-Cylinder Motor

Operation	Production Required	Production Obtained	Cutters: Type	Cutters: Diameter, Inches	Cutters: Material	R.P.M.	Cutting Speed, Feet per Minute	Feed, Inches per Minute	Chip per Tooth, Inch	Stock Removed, Inch
Cylinder Blocks										
Mill oil-pan face; slot for bearing caps (Fig. 5)	12	16	2 Inserted-blade face mills	6 1/2	T.C.	107	183	19	0.0089	1/8
			1 Inserted-blade end-mill	6 3/4	J-Stellite	64	113	10	0.0098	1/8 to 3/16
Rough-mill cylinder head seats and finish-mill valve cover faces (Fig. 6)	12	18	2 Inserted-blade face mills	7	T.C.	111	204	12 3/4	0.0058	1/8
			2 Inserted-blade face mills	5 1/2	T.C.	155	223	12 3/4	0.0052	1/8
Finish-mill cylinder head seats, and mill top and water-jacket pad (Fig. 7)	12	18	2 Inserted-blade cutters	7	T.C.	111	204	14 5/16	0.0064	1/32
			2 Inserted-blade cutters	4	T.C.	189	199	14 5/16	0.0076	1/8
Mill cylinder block ends (Fig. 8)	12	13	2 Inserted-blade face mills	18	J-Stellite	31	146	7	0.0057	1/8
Straddle-mill main bearing sides (Fig. 9)	12	52	6 Half side-mills	6	H.S.S.	49	77	5	0.0085	1/8
Cylinder Heads										
Mill cylinder head bottom (Fig. 10)	24	24	Inserted-blade face mill	7	T.C.	110	202	15	0.0069	3/32
Mill manifold, valve cover face and hold-down bosses (Fig. 11)	12	14	1 Inserted-blade shell end-mill	4 1/2	Stellite	111	131	10 1/2	0.0086	1/8
			1 Inserted-blade formed mill	6	Stellite	86	120	10 1/2	0.0100	1/8
Mill ends and seal pad (Fig. 12)	24	57	2 Solid shell end-mills	4	Stellite	111	117	8	0.0036	1/8
			1 Shell end-mill	2 1/4	H.S.S.	111	66	8	0.0072	1/8



Figs. 5 to 12. Diagrams Showing Milling Operations Performed on Cylinder Blocks and Heads

tact between blades and work. The cost of tungsten carbide for this cutter would have been prohibitive and the intermittent nature of the slotting cut would have imposed too much shock for satisfactory results.

Fig. 6—Tungsten carbide was used to obtain production. The requirements are ideal for this material. Great rigidity was provided for this, as well as for the previously described operation, by supporting the top of the fixture by a guide fastened to the body of the machine.

Fig. 7—Tungsten-carbide cutters were used to obtain an excellent finish at a high rate of speed on the cylinder-head faces.

Fig. 8—J-Stellite was used because it mills faster than high-speed steel and is cheaper than tungsten carbide. The use of tungsten carbide would have required an additional investment of $1070 in cutters. This would not have been justified, since the less expensive cutters gave satisfactory results.

Fig. 9—This equipment is capable of producing over four times the requirements, when using high-speed steel cutters. The increased cost of tungsten-carbide cutters would not, therefore, be justified.

Fig. 10—Here tungsten carbide is used to obtain a good flat surface in one cut and at a high rate of production.

Fig. 11—In this case, Stellite was chosen instead of tungsten carbide primarily because of the 2-inch length of angular contact and the hammering action of the cut. Good results could not have been expected from tungsten-carbide cutters.

Fig. 12—Here one Stellite cutter and one high-speed steel cutter ran on the same spindle. A satisfactory cutting speed was obtained for each. Since the equipment is capable of producing over twice the requirements, the additional cost of tungsten-carbide cutters would not have been justified.

Summary of the Factors to be Considered in Deciding upon Cutter Material to Use

Summarizing, we may say, therefore, that the selection of the proper material for a milling cutter to be used on a specific job can only be made after a careful evaluation of all the factors concerned. These factors are: (1) The type of cutter required; (2) the material to be machined; (3) the production required and the method to be used in obtaining it; (4) the finish required; (5) the rigidity (or lack of rigidity) of the work; (6) the milling machine available; (7) the first cost of the cutters; and (8) the cost of cutter upkeep.

Bearing these considerations in mind, other factors must be considered also, such as the attitude of the shop personnel toward the new cutting material, the training of the personnel in the handling and sharpening of the tools, etc. It is of importance to note that these new carbide tools have been most successful in plants where they are extensively used.

The final decision depends upon analyzing all these conditions and using the best judgment based on long experience with milling operations. There is no royal road to success in the use of carbide tools, but an understanding of the various factors involved will aid in securing the great economies possible with these remarkable cutting materials.

Using Super-Hard Tools for Planer Work

A Brief Review of the Factors Involved in the Application of the New Cutting Tools to Planer Work and their Effect on Planer Design

ASKED about his opinion as to the application of tungsten-carbide tools to planer work, George Langen, vice-president and works manager of the Cincinnati Planer Co., stated that where the work is of a rather light character, requiring only light cuts, the new carbide tools can be used successfully on planer work. This means, however, that higher speeds are required than those ordinarily provided in present planer designs. Furthermore, to secure good results, it has been found necessary to use a very heavy planer, even for light work, so as to reduce the vibration both in the machine and at the tool point.

On the regular run of planer work, these tools have not yet been found applicable, because most of the work is of such a character that it requires deep cuts and coarse feeds, while the new type of tools lend themselves to high speeds and fine feeds.

Should the new cutting tools be so improved that they can be used on the regular run of planer work, it would be necessary not only to design planers for higher speeds, but to increase the weight to absorb vibrations at the tool point. One of the difficulties will be to secure enough weight and rigidity without making the tool-slides and similar parts too bulky and cumbersome for quick operating on the lighter and medium classes of work.

Improvements in the New Tool Materials will Greatly Increase their Application

Forrest E. Cardullo of the G. A. Gray Co., Cincinnati, Ohio, states that this company has had very encouraging results in planing with tungsten- and tantalum-carbide tools, but as yet the tools have not been developed to the point where they are economically profitable to use for ordinary planing in the average shop. If present difficulties with these tools can be overcome, there is no question but that very good results can be obtained. The experience on planer work, however, has been that the cost of tools and tool grinding has been so great that first-class grades of high-speed steel are still to be recommended commercially for most planing.

Effect of the New Tools on Planer Design

The effect of the introduction of satisfactory super-hard cutting materials on planer design, may be stated as follows:

1. A great reduction in cutting time will make advisable any convenience that will reduce the tool-setting time. Rapid traverse will become essential, and the rapid traverse must be such as to operate with a minimum of attention on the part of the operator. It is essential that a single motion shall accomplish everything necessary to the rapid traverse of the tool, and that a return to the neutral position shall return the feed mechanism and other parts of the planer to their initial condition.

2. Anything that will make it more convenient to adjust the tool to the exact position required will be worth while. Control at the head and close to the tool point becomes highly desirable.

3. A tool-lifter is necessary. Obviously, the tool-lifter should be of such design that it does not need continual adjustment, but will operate, no matter what the position of the slides upon the saddles or the saddles upon the rail.

4. Proper design of the various parts for rigidity becomes extremely important. Fine workmanship, which cuts to a minimum running clearances and leaves little or no play in the parts, will be much more important. A small gain in rigidity due to increased weight of tool-holding parts is of no value if the workmanship is inferior and permits appreciable movement of the tool.

5. High cutting speed—possibly up to 125 feet per minute—will be desirable; and this will require a corresponding increase of return speed. Motors of higher power must be employed and quick reversal must be one of their characteristics.

Planer Accessories Must be Improved

Much better equipment for holding work, in order to reduce the time necessary for set-up, will be needed. Most planer hands are provided with a few bolts, clamps, and wedges, usually in poor condition, and a good deal of time is wasted hunting for the proper clamping equipment. So long as an old-fashioned planer is used, running at speeds of 25 or 30 feet per minute, this does not add seriously to the floor-to-floor time. However, when work is done so quickly that the set-up time becomes one-half or three-quarters of the total time for the job, this matter requires serious attention.

In most shops, the planer is the only tool that receives but little attention from the production engineer. A planer job is usually given to the planer hand without instructions, and he is expected to do his work without assistance. The use of the new cutting tools will bring out the fact that planer work requires the serious attention of the production engineer and proper accessory equipment, in order that the most efficient work may be done.

"Finally," says Mr. Cardullo, "I hope that planers built forty, thirty, and even twenty years ago, will be put in the scrap heap, for they are not suitable for use with the new cutting materials. There can be no reduction in cutting time unless these planers are speeded up far beyond the speeds for which they were designed."

The Application of Carbide-Alloy Tools to Turret Lathes

An Investigation to Determine whether Modern Turret Lathes Meet the Requirements of the Tungsten-Carbide Cutting Alloys

By GEORGE M. CLASS
Gisholt Machine Co., Madison, Wis.

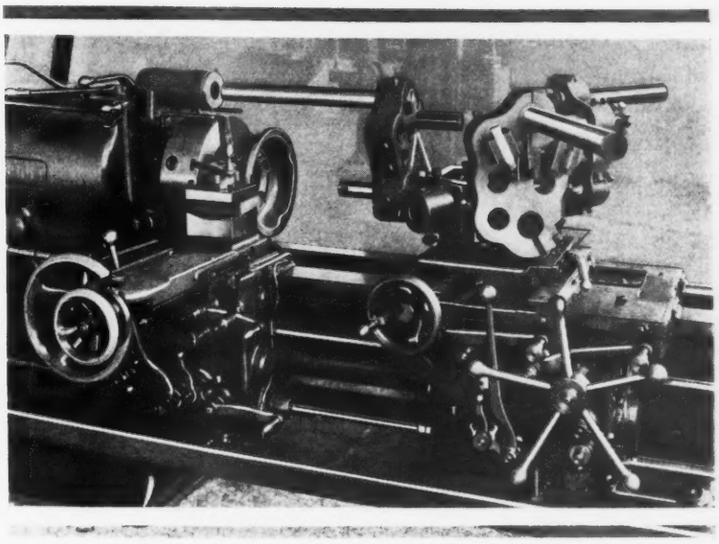


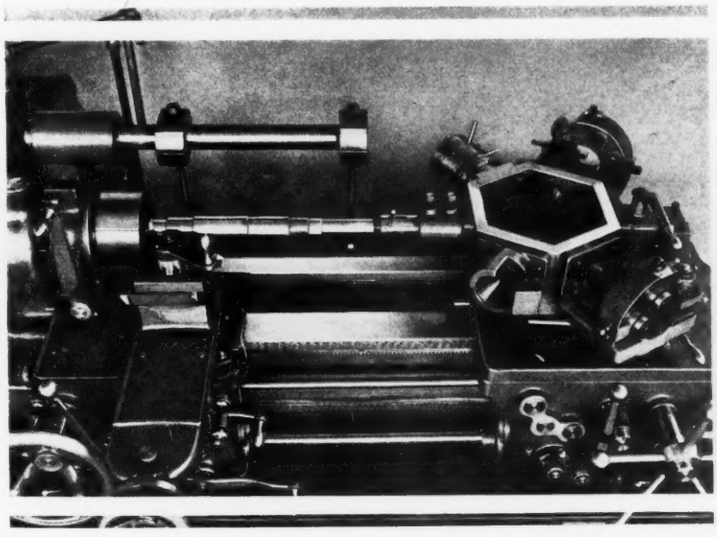
Fig. 1. Electric Motor End-shield Being Machined in Turret Lathe with Tungsten-carbide Tipped Tools

THERE has been a prevalent belief that the advent of cemented-carbide cutting alloys would necessitate a complete redesign of all types of machine tools. It has therefore been a not unpleasant experience for makers and users of modern turret lathes to find that their machines are surprisingly well suited to the effective use of these new cutting alloys.

The reason becomes apparent if we consider the work for which modern turret lathes have been designed. Rapid removal of metal for reduction of diameters, as in heavy bar work, resolves itself essentially to a question of cubic inches per minute of metal removed, whether tools of high-speed steel or carbide alloys are employed. When large amounts of metal are to be removed from a surface, deep cuts and coarse feeds at slower surface speeds are frequently most effective. Turret lathes have been designed in recent years to perform such work satisfactorily with high-speed steel tools. Headstock gearing and clutches have been made more powerful and durable, and the spindle and bearing construction has been strengthened to withstand the heavy loads of bar and chucking work.

It is only necessary, therefore, that the design be capable of accommodating the higher surface speeds incident to the use of carbide alloys, whose best performance is secured from the use of greatly increased speeds with shallow cuts and finer feeds.

Fig. 2. An Electric Motor Armature Shaft on which Some of the Operations are Performed with Tungsten-carbide Tools



What Design Factors are Influenced by the New Cutting Tools?

In view of the fact that the power of headstock clutches, shafts, and gearing increases as their speed is increased, the chief requirement is that the bearings and gear circumferences be designed to withstand such increases, and that the beds and tool-supporting units be sufficiently massive and rigid to eliminate vibration. Sources of vibration must be removed, such as eccentricity of gearing and unbalance in rotating parts. Unbalance, because of the forces that it brings into action, which increase as the square of the speed, is particularly objectionable, whether due to eccentricity or to other incorrect distribution of mass. Anti-friction bearings are used extensively on turret lathes of recent design, and tool-supporting members

have been made of ample mass for the pressures they must withstand, even with the use of the carbide alloys.

For example, the Gisholt 4L turret lathe weighs 20,000 pounds and has a spindle 11 1/2 inches in diameter. It has a normal high speed of 145 revolutions per minute (556 surface feet on a 12-inch diameter), and is ordinarily driven by a 25-horsepower motor. The V-belt drive (intentionally the weakest point in the drive) has a capacity of 28 horsepower; the disk clutch, 55 horsepower; the low-speed gear, 62 horsepower; and the high-speed gear, 209 horsepower. At 290 revolutions per minute, or double the normal high speed (1100 surface feet on a 12-inch diameter), these capacities increase as follows: V-belt drive, 51 horsepower; clutch, 109 horsepower; low-speed gearing, 93 horsepower; and high-speed gearing, 261 horsepower.

On the smaller Gisholt 2L turret lathe, which is normally powered with a 10-horsepower motor, similar conditions of capacity are present. Tests have been made on this machine in a customer's plant to determine performance with the recently developed cutting alloys. The results of these tests are recorded in the accompanying table.

No wear was apparent on any of the tools used in the tests, although a large amount of each material was turned. In all cases, except that of S A E-5160, it was possible to break the chip readily into small pieces by proper grinding of the tools. S A E-5160, being an excessively tough material, would not break into short chips, but curled and broke readily into coils, perhaps 12 inches long.

In the experimental department of the Gisholt Machine Co., these different grades of steel have been turned at much higher speeds than those listed in the table; but because of chip and coolant conditions, these higher speeds are not entirely practical, except where small amounts of material are to be removed, in which case the limit to the cutting speed seems very remote. These tests would indicate that for all practical purposes, turret lathes of modern design are fully abreast with the present requirements of the carbide alloys.

From these and other tests, it is also apparent that there is still a definite and important use for high-speed steels. When a great reduction of stock is desired or when heavy interrupted cuts are to be taken, good high-speed steel appears, so far, to be more economical than the available carbide alloys. When work is subject to distortion, however, the carbide alloys seem to present the advantage of leaving it cooler and also of making it easier to maintain close tolerances, in cases where this is required.

Tests Made in Machining Steel on Turret Lathes Using New Cutting Alloys

Cutting Metal	Material Cut, S A E Steel No.	Diameter of Bar, Inches	Depth of Cut, Inch	R.P.M. of Spindle	Surface Feet per Minute	Feed, Inch	Horsepower Required
Alloy No. 1	1020 M.S.	3	3/8	242	195	0.021	13
	1020 M.S.	3	3/8	242	195	0.034	18.2
	1020 M.S.	3	3/8	484	380	0.021	25
	1045 M.S.	2 3/4	3/8	242	174	0.021	17.7
	1045 M.S.	2 3/4	3/8	333	240	0.021	19.8
	1045 M.S.	2 3/4	3/8	420	302	0.021	21
	2340	3	13/32	196	154	0.017	13.5
	2340	3	13/32	242	195	0.021	19.4
	2340	3 1/4	1/2	484	410	0.017	34
	5160	2 7/8	7/16	242	182	0.021	16
	5160	2 7/8	7/16	333	250	0.021	21
	5160	2 7/8	7/16	493	370	0.021	30
	Boiler Plate	14 1/4	5/16	108	396	0.021	23
Alloy No. 2	1045 M.S.	2 3/4	3/8	242	174	0.021	14.5
	1045 M.S.	2 3/4	3/8	333	240	0.021	17.1
	1045 M.S.	2 3/4	3/8	420	302	0.021	22

A PROGRESS RECORD IN THE ART OF CUTTING METAL

Meeting of the American Welding Society

The American Welding Society held its annual meeting in the Engineering Societies' Building, New York City, April 27 to 29. A great number of papers pertaining to welding, and to the properties of metals as affected by welding, were presented. In a symposium on the ductility of welds, a number of unusual papers were presented covering the subject from many different points of view.

Welding in shipbuilding was given thorough consideration in three papers prepared by men thoroughly familiar with and engaged in ship construction, both for the merchant marine and for naval purposes. The subject of pipe welding was also dealt with in a number of papers, and machine gas welding formed the subject of another paper and discussion. One of the papers presented a study of the transformation points of fusion weld metal, another discussed spot welding in the fabrication of the airplane structure, and still another dealt with the welding of extruded metal. Many other papers were presented, a list of which, together with copies of selected papers, can be obtained by addressing M. M. Kelly, secretary, American Welding Society, 33 W. 39th St., New York.

Principles of Hydraulic Systems Applied to Machine Design

A Brief Description of the Principal Units Used in Hydraulic Systems Designed to Obtain Mechanical Movements Second of Two Articles

By CARL MOREY, Consulting Engineer
Big Rapids, Mich.

IN April MACHINERY, the general principles of systems used for obtaining mechanical movements by the application of hydraulic pressure were outlined. In the present article, the principal parts of such systems, including pumps, rotary motors, cylinders, operating valves, and reversing valves will be briefly described.

The most widely accepted designs of power pumps are basically of the positive displacement type. They include the constant displacement, variable displacement, and adjustable displacement types. The centrifugal pump is also used, but its application is limited.

Under the heading of constant-displacement pumps we have the gear pump, the vane pump, and the plunger pump. There are also many other designs of pumps, but their application is limited.

Fig. 1 shows the simplest form of gear pump. This pump is, perhaps, the most popular design, as it is simple to build, operates with relatively high efficiency, and is compact and durable. It is suitable for many drives using pressures under 1000 pounds per square inch, and where throttling is used for speed control. It can be designed to operate at electric motor speeds, thus eliminating gearing or belts.

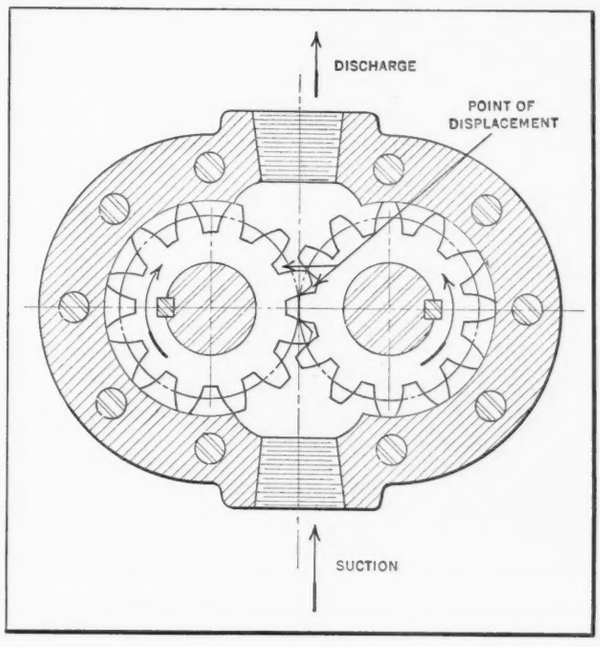


Fig. 1. Simple Form of Gear Pump

Fig. 2 shows a typical vane pump. It has practically the same characteristics as the common gear pump, and is suitable for pressures up to 1000 pounds per square inch. It has a very high volumetric displacement for its size, usually about twice that of a gear pump of the same weight and size for well designed units. It is positive and has a constant displacement with few moving parts. There is practically no pulsation.

Fig. 3 shows a multiple-cylinder plunger pump, designed for constant displacement. It will be noted that the cylinders are arranged with their axes parallel to the drive shaft. The plungers are actuated by a sloping plate. Both the cylinder assembly and the plunger assembly with the sloping plate revolve about the axis of the drive shaft. Various numbers of cylinders are used, usually five or more. The valve mechanism consists of

CARL MOREY was born in 1893. In 1903 his father, the late William Morey, a consulting engineer, wrote a book on internal combustion engines containing illustrations executed by his ten-year-old son. From that date up to the present time, Carl Morey has been associated with engineering work, except for three years in which he completed a four-year course at the Westbrook Seminary, Portland, Me. Mr. Morey's experience has covered an unusually broad line of engineering, such as excavating and material-handling machinery, rolling mills, metal-grinding equipment, turret lathes, deep drilling machines, hydraulic and mechanical presses, and paper and rubber mill equipment. He has been connected with the General Electric Co., the Worthington Pump & Machinery Corporation, the Marion Steam Shovel Co., the Aluminum Company of America, the Farrel-Birmingham Co., and the Landis Tool Co. During the last three years he has been engaged in consulting work, specializing on the application of hydraulic principles to machine design. Mr. Morey is a member of the American Society of Mechanical Engineers.

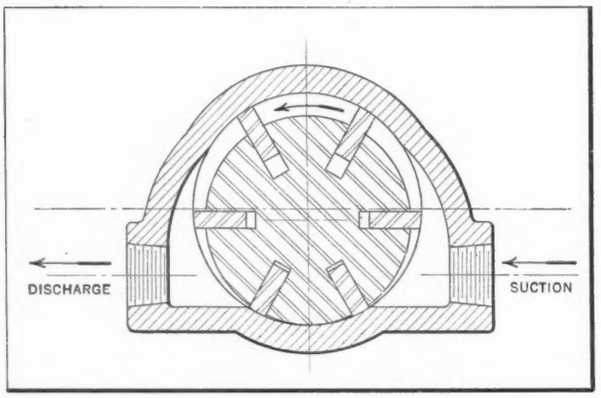


Fig. 2. A Typical Vane Pump Having Constant Displacement

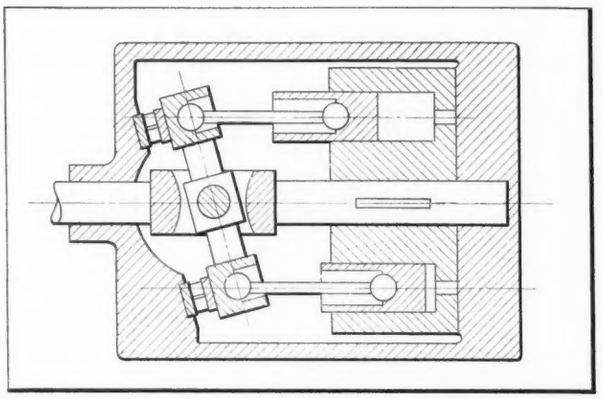


Fig. 3. Multiple-cylinder Constant-displacement Plunger Pump

a ported plate, so arranged that when the cylinder assembly slides on it, the cylinder ports line up with the valve plate ports in proper sequence.

Fig. 4 shows a design of a multiple cylinder pump in which the cylinders are disposed radially about the crank. The eccentricity *X* is fixed for constant displacement. In this type of pump, the cylinder, with the pistons and driver, rotates as a unit assembly. Due to the eccentricity *X*, there is a tangential movement of the pistons in relation to the driver. Rollers are provided to reduce the mechanical friction between the bases of the pistons and the driver. The valve is stationary, and is ported to match with the ports in the cylinder unit, in the same manner as in Fig. 3. The difference is in the construction only. As in Fig. 3, the cylinders are single-acting, and the hydraulic characteristics are identical. This pump can be built for pressures up to 3000 pounds per square inch.

Since in both Figs. 3 and 4, the cylinders are single-acting, the pulsation frequency per minute for both types is as follows: Pulsation frequency per minute equals number of cylinders times the revolutions per minute.

The four designs described are the most widely used. They range in cost for equivalent capacity in the order mentioned, the gear pump being by far the least expensive.

Power Pumps with Variable Displacement

Fig. 5 shows a variable-delivery pump of similar design to the constant-displacement type shown in Fig. 3. It will be noted that the base of the sloping plate has a circular seat on which it is swung through the arc *X*. When this baseplate is in the vertical plane, the plungers will have no longitudinal movement, and will, therefore, displace no fluid. By continuing this swinging motion through the arc *Y* it is apparent that the displacement will be increased again to the maximum, though the circulation of the fluid will be in the opposite direction. The valve plate shown in the section at *A–A* is common to both the constant and variable designs.

Referring to Fig. 4, it is obvious that should the eccentricity indicated at *X* be reduced, the plunger travel would be correspondingly reduced, and the displacement of the pump would be decreased. Therefore, when the eccentricity is reduced to zero, the displacement also will become zero. Now if the eccentricity is increased through the space *Y*, the pump will again displace fluid, though the direction of flow will be reversed.

It is obvious that the designs shown in Figs. 3, 4 and 5 are basically the same, the only difference being in the disposition of the cylinders.

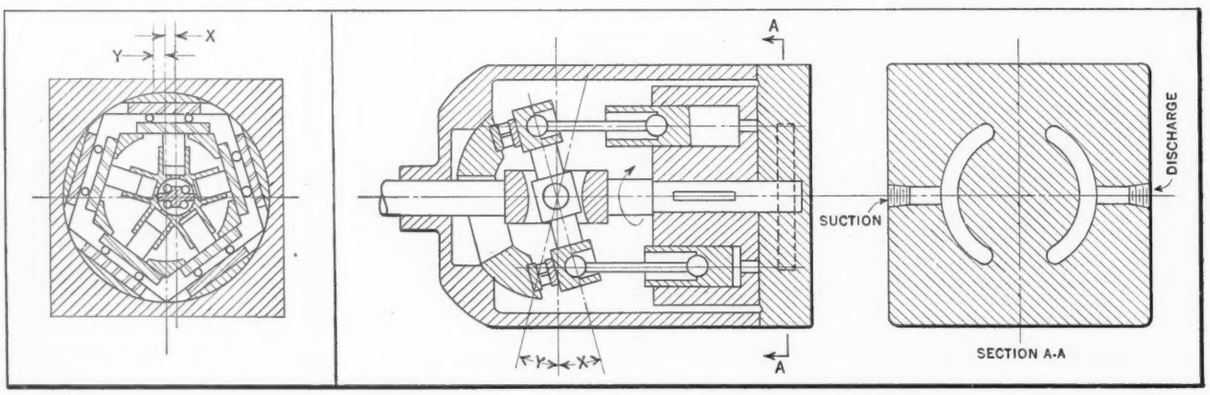


Fig. 4. (Left) A Multiple-cylinder Pump with the Cylinders Arranged Radially about the Crank
Fig. 5. (Right) A Multiple-cylinder Plunger Pump for Variable Delivery

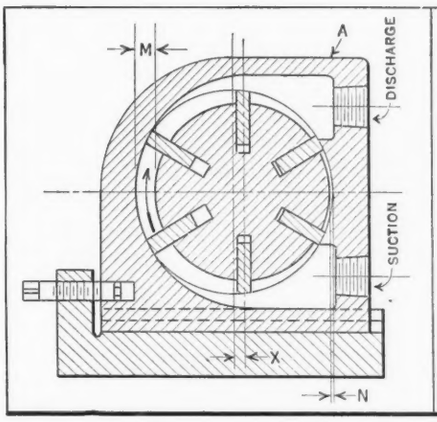


Fig. 6. Design of a Variable-displacement Vane Pump

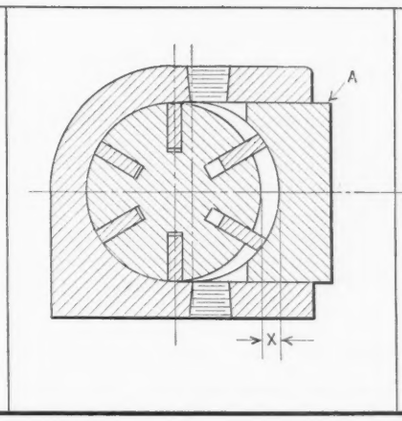


Fig. 7. Another Variable-displacement Vane Pump

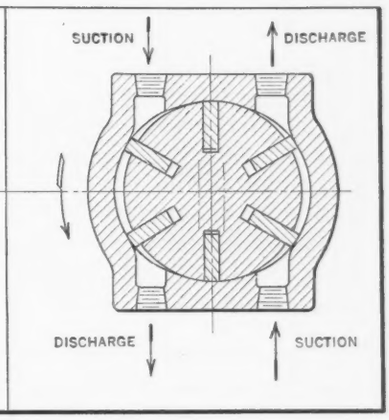


Fig. 8. A Commercial Type of Adjustable-displacement Pump

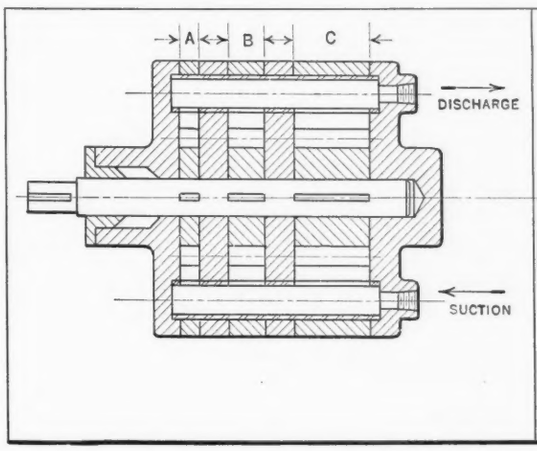
Fig. 6 shows a variable-displacement vane pump in which the housing *A* is moved eccentrically relative to the rotor, thus varying the distances *M* and *N*. It will be noted that when distance *X* equals zero, *M* equals *N*, and the pump will cease to displace fluid. This design has the same hydraulic characteristics as the pump shown in Fig. 2.

Fig. 7 shows another form of the variable-displacement vane pump. This design is provided with a sliding block *A* which forms part of the wall of the housing. It is apparent that should the value of *X* be reduced, the effective area, and consequently the displacement, would be reduced proportionately. This pump has one objectionable feature. Owing to the moving out of the wall, there is a flat spot top and bottom where the normal bore of the housing and the bore of the sliding block are joined by the tangent portion in which the block slides. The flat spot causes the blades to have an irregular movement; that is, the rate of acceleration and deceleration is not constant. The operating speed of the pump is therefore somewhat reduced. The hydraulic characteristics are the same as those of the pumps in Figs. 2 and 6. The displacement equals the effective area of the blade times the mean velocity.

Designs of Adjustable-Displacement Pumps

Fig. 8 shows a commercial pump arranged with two chambers of displacement. This pump is of the vane type, and both chambers have the same delivery. By arranging selective valves, either or both chambers can be used. The pump will, therefore, deliver fluid of two capacities, one capacity being twice the other. Since it is designed on the vane principle, all the hydraulic characteristics of the vane pump apply to this pump.

Fig. 9 shows an adjustable-displacement pump having three stages of displacement. The illustration shows the gear type, though it is commercially built on the vane principle also. It will be noted that the *B* chamber is twice as wide as the *A* chamber, and that the *C* chamber is twice as wide as the *B* chamber, or four times that of the *A* chamber. Therefore, with the proper valves for selecting the various chambers, seven values of displacement are obtainable. A two-chamber pump will provide three stages of displacement; a three-chamber pump, seven stages; a four-chamber one, fifteen stages, etc. This pump is easily manufactured, and gives an attractive speed range, where steps in speed are permissible.



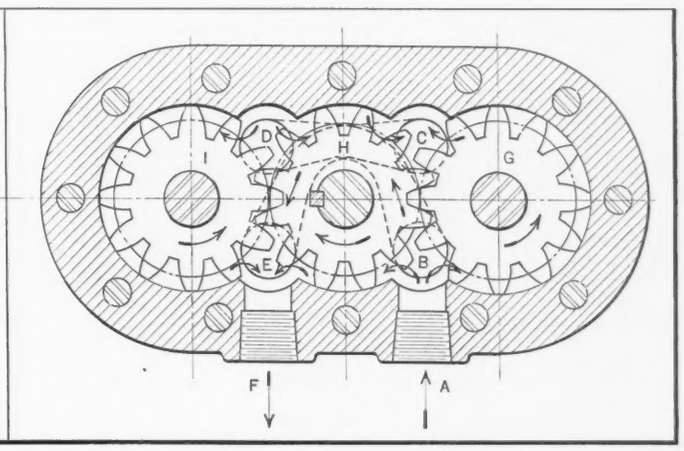


Fig. 9. (Left) A Three-stage Adjustable-displacement Pump; Fig. 10. (Right) The Hydraulic Gear Motor

Hydraulic Rotary Motors

Referring to Fig. 1, it is evident that should a fluid be admitted at the suction connection under pressure, it would, of necessity, rotate the gears in order to pass through the unit. It would follow the same path as indicated for the pumping condition. The theoretical speed of rotation would be the same as in a pump with the same pitch, number of teeth, and width of face. It therefore follows that the unit would become a hydraulic motor. The power delivered would be dependent upon the speed of rotation and the working pressure of the fluid. It can then be considered that a gear pump and a gear motor will be duplicates as far as hydraulic characteristics are concerned.

Fig. 10 shows a hydraulic gear motor having three gears in mesh and four fluid paths. This design is interesting in that three gears provide for four paths, and the displacement of the motor is twice that of a single pair of gears. The gears in the illustration are arranged with the drive shaft keyed to the center gear and the two outside gears idling. This gives a symmetrical design and a uniform distribution of loading. Oil under pressure is admitted at *A*. It then passes around gears *G* and *H* in the direction of the arrows. Chamber *B* is connected to chamber *D* by a port. The oil then passes from *D* around gears *H* and *I* to chambers *C* and *E*, respectively. At *E* it is discharged through *F*.

Fig. 11 shows a so-called "cam motor." It is built commercially with two two-lobe cams as shown. The arrows show the path of the fluid. Two intakes and two discharges are shown, but it is apparent that by a system of porting, the two intakes can be combined and the two discharges combined, thus constructing the device with one intake and one discharge. For the rear cam (shown dotted), the blades are placed in the same plane as those shown to reduce pulsation.

Following the same ideas, the pumps illustrated in Figs. 2, 3, 4, 5, 6, 7, and 8 may be modified slightly to act as rotary motors. Those in Figs. 3, 4, 5, and 8 are built commercially.

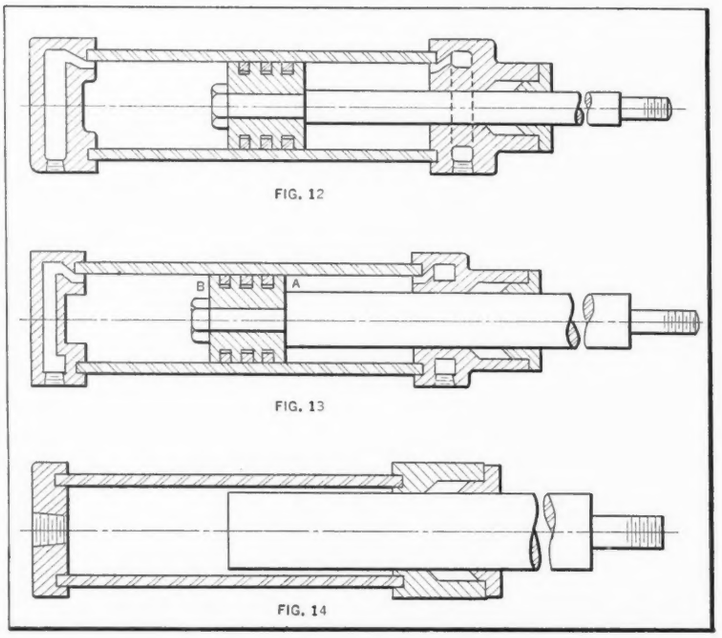


Fig. 12. Simple Type of Hydraulic Cylinder; Fig. 13. Differential Type of Hydraulic Cylinder; Fig. 14. An Outside-packed Single-acting Cylinder

Important Points in the Design of Cylinders

Ordinarily, cylinders do not present a serious problem to the designer, yet there are one or two points that should be considered if certain troubles in operation are to be avoided.

Fig. 12 shows a common cylinder, piston, and rod. The piston is packed and the rod is packed. It will be noted that the points of admission and discharge are at the top. This permits the cylinder to retain its fluid, and also allows for a flushing action when the fluid is discharged, thus providing a means by which air or gas can be removed from the system. It also eliminates the use of bleeders.

Fig. 13 shows a differential cylinder. It will be noted that the effective area at *A* is considerably

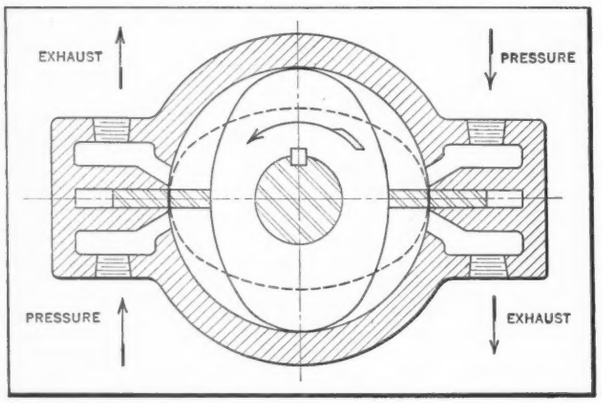


Fig. 11. Section of a So-called "Cam Motor"

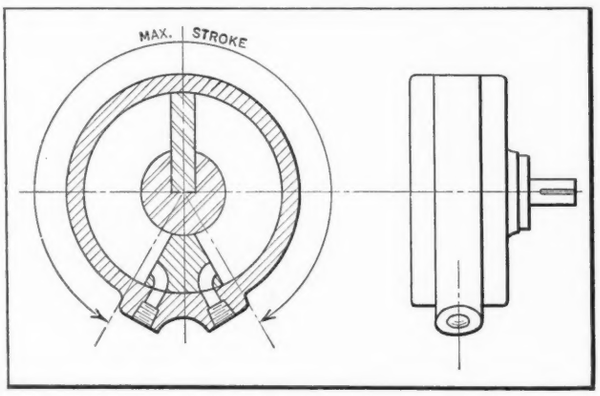


Fig. 15. Principle of the Paddle Motor

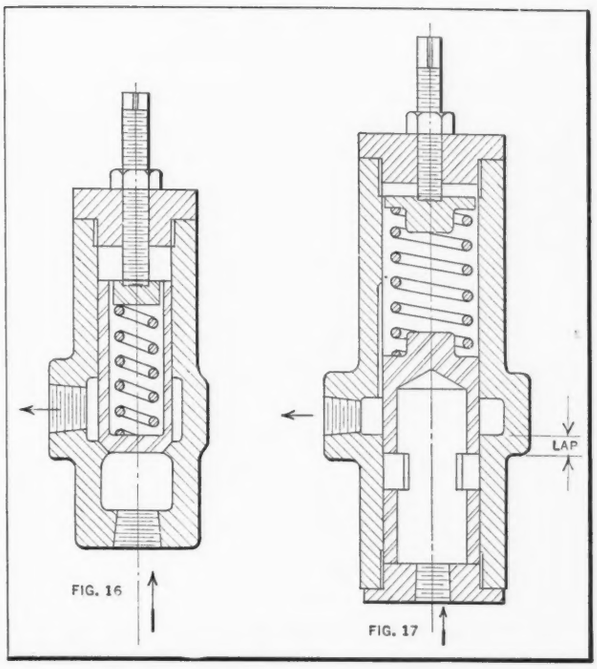


Fig. 16. Typical Poppet Type Relief Valve

Fig. 17. Typical Piston Type Relief Valve

smaller than that at *B*. This gives a differential of speed at constant delivery and pressure. This construction is particularly adapted to conditions where a high speed is required in one direction and a low speed in the opposite direction.

Fig. 14 shows an outside-packed single-acting cylinder. Ordinarily two cylinders are required for reciprocating motion. This design is inexpensive to build in that it requires no internal grinding, no inside packing, and eliminates delicate fitting. On very long cylinders, the ram can be made of tubing plugged at the outer end. This allows the driving force to be applied at the outer end, thus removing the column effect, reducing the weight of the moving member, and giving a much stiffer construction.

In addition to the more common forms of cylinders described, there is the so-called "paddle motor." The principle is old, since it was applied to a washing machine many years ago. It is, however, an interesting device, as it can be used in many applications. As shown in Fig. 15, it consists of a rather narrow body, bored cylindrical, in which a shaft with an arm is partially rotated. In this cylinder is placed a block ported for admission and discharge. The angle of rotation is usually about 300 degrees. This design has been used successfully as a drive for the table of a cylindrical grinder, for swinging the arm of a swing grinder, and for many feed mechanisms.

Various Types of Operating Valves

Under the heading of operating valves are included relief valves, throttle valves and reversing valves. The function of the relief valve may be twofold. Ordinarily, it is merely a protective device to relieve the system of abnormal pressures due to reversing, hydraulic hammers, etc., though it may act as a pressure by-pass valve when installed in the throttling system. There are several types available, including the poppet and piston types. The latter is preferable, since it is quieter in operation, and is more economical to build. Fig. 16 shows a typical poppet type relief valve, while Fig. 17 shows the piston type. It will be noted that no "wire drawing" is possible across the seat of the piston valve, and that there is only metal-to-metal contact when the pressure falls so low that circulation is cut off entirely by the lap indicated.

Fig. 18 shows a Corliss type throttle valve. The stem rotates, and a lever attached to it passes over a graduated arc, thus indicating the speed. As in the piston relief valve, this design practically eliminates "wire drawing." Fig. 19 shows the more common needle valve. Several revolutions are required to open it to full capacity. This increases the difficulty of graduating for the various speeds.

The reversing valve is a very important part of any hydraulic system where it is required. It is by far the most difficult to design, and causes more trouble than any other unit. There are as many designs of reversing valves as there are designers doing hydraulic work. The basic function of a reversing valve is to reverse the flow of the fluid, and to accomplish this, a "load and fire" mechanism, usually spring-actuated, is added. To this basic arrangement several other functions may be added. Among these are starting and stopping;

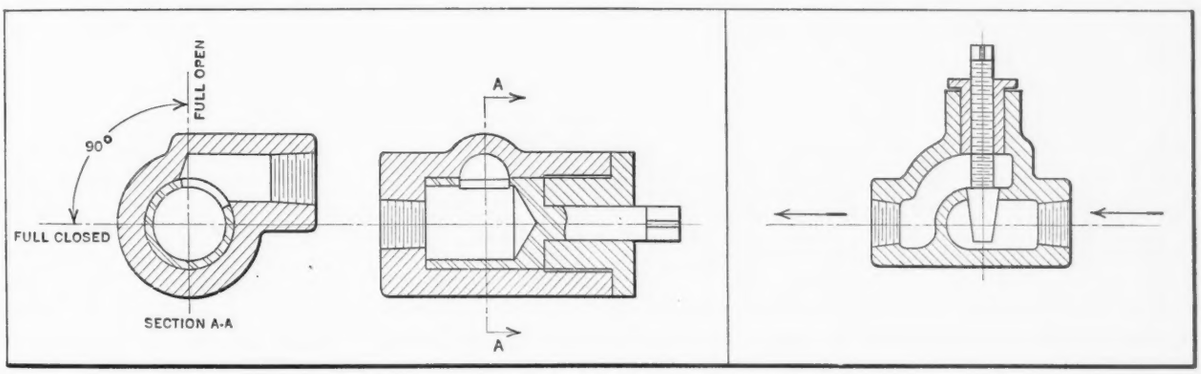


Fig. 18. Corliss Type Throttle Valve

Fig. 19. Common Form of Needle Valve

by-passing the cylinder ends, so that the cylinder is not hydraulically locked, thus preventing hand movement; and by-passing the pressure line, so that the pump will not be required to deliver its full capacity through the relief valve. A bleeder or dashpot may also be included, so that the moving mass will not develop a heavy impact on reversal, which would be the case should the flow of oil be stopped instantaneously.

These valves are built upon several principles —piston type, Corliss or rotating type, poppet type, and disk type. The piston type is by far the most popular, since it is self-balancing, easy to manufacture, and lends itself to the adaptation of special functions.

Fig. 20 shows a section of a typical piston type reversing valve. The seat or sleeve is machined all over and the ports are milled. It is then pressed into the body, which is cored for the various passages. This construction permits of generous cores, and enables the ports to be machined very accurately. The valve spool is lapped to fit the sleeve, and the matching of the spool and ports is a simple matter. The load-and-fire mechanism is spring-actuated. This valve includes also a by-pass for the cylinder ends, which is shown by the drilled hole in the spool, a start and stop device, which is mounted externally, and a dashpot effect top and bottom to retard the valve movement and cushion the piston travel. This type of valve is very popular, and is used for reversing the table travel on cylindrical, surface, and face grinding machines.

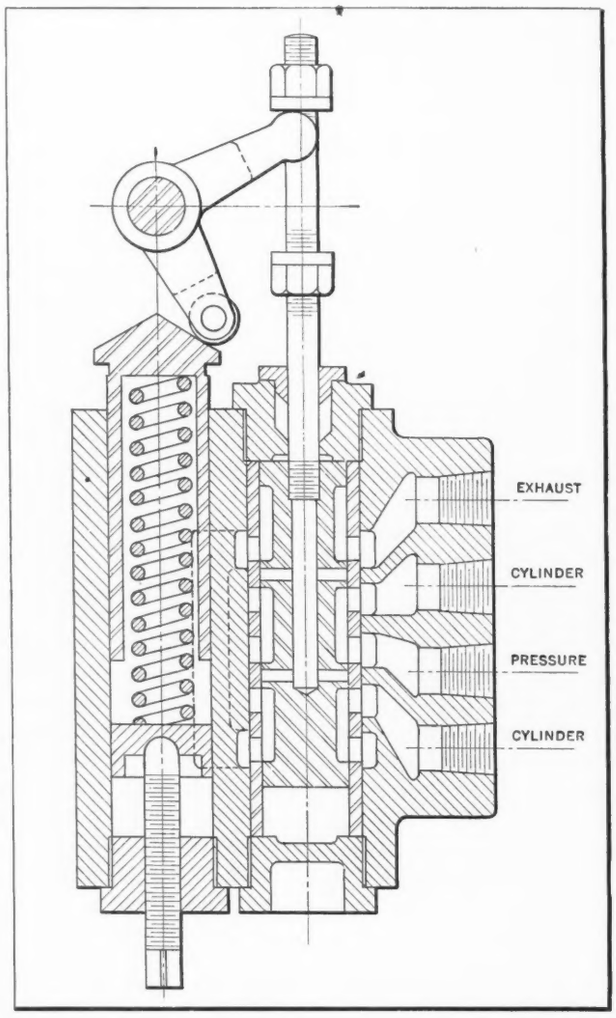


Fig. 20. Typical Piston Type Reversing Valve

As previously stated, the ease with which this valve can be modified to introduce additional functions makes it adaptable for many fields. Modifications are found on gear-cutting machines, turret lathes, drilling machines, and polishing machines.

* * *

Even engineering ideas may be too far ahead of the times. The secret of success is to invent when the world is ready for the invention.

A Survey of Industrial Opinion on Economic Questions

Ohio State University has issued, as Circular No. 26 of the Engineering Experiment Station, a booklet entitled "Economic Attitudes in Industry." In this book are answered fifteen questions having to do with fundamental problems and policies in industry. The answers are those received from four hundred industrial leaders and forty-five economists to whom the questions were put. The answers were analyzed and arranged by members of the faculty of Ohio State University.

Throughout the opinions, as expressed by these industrial leaders, there is a definite belief that it will be possible to secure, through a rational handling of industrial problems, a fair degree of well being and comfort to all workers. As to the methods and agencies through which this rational handling of industrial problems can be secured, there is a great diversity of opinion. Business leaders in general do not favor government activities except, perhaps, in national emergencies, whereas among the economists there is a large group who have come to the conclusion that many of the problems can be solved properly only through uniform methods and control, and that such uniform control can be secured only by government guidance and authority.

On the other hand, such questions as old age pensions, unemployment insurance, and a shorter working day find wide support even among industrial leaders, and there seems to be little hesitation in admitting that labor organizations, if they would work along broad ideas and principles, could furnish a distinct aid in the solution of many of these problems.

There is almost unanimous agreement on the need of more cultural training and a broader social and economic outlook among industrial executives, and numerous suggestions are given as to topics of study that would aid engineering students in obtaining this broader outlook.

Selecting Suitable Wheels for Grinding Carboloy

A PROGRESS RECORD IN THE ART OF CUTTING METAL

By A. MacKENZIE, Carboloy Company, Inc.

IT was realized in the very early stages of Carboloy development that grinding has an important influence on the performance of tools made from this material. This necessitated the development of suitable grinding wheels. Considerable progress has been made in a relatively short time, both in the art of using the wheels and in the construction of the wheels themselves. Much, however, remains to be done, as the proper grinding of Carboloy is still a relatively expensive operation.

At the outset, wheel selection was based on the observation and opinion of our different factory superintendents and their men. We soon realized that there was a great difference of opinion as to what constituted the ideal wheel. Men handling the same type of work on similar machines did not agree as to the kind of wheel required. As a large percentage of our work is of a job-shop nature, it was practically impossible to prove conclusively the merits or demerits of any one wheel under regular production conditions.

This difference of opinion and lack of conclusive proof, plus the fact that we were encountering considerable grinding trouble, forced us to develop a method of conducting tests that would give definite evidence of the suitability of a wheel for grinding Carboloy. While the method of testing developed for this purpose is not entirely fool-proof, it does definitely answer the first and by far the most important question as to whether the wheel being tested has any harmful effect on the Carboloy. It also provides a means of comparing the life of the wheel being tested with that of other wheels. It is essential that the wheel pass the first requirement, after which we take into consideration the wheel life. Naturally, there is a happy medium as regards both requirements.

The procedure we have adopted as standard in making our tests is outlined in the following: A Brown & Sharpe No. 2 surface grinder, in good mechanical condition, having a spindle speed of 3200 revolutions per minute is used for this purpose. The table is operated at a speed of 34 strokes per minute lengthwise of the piece being ground and with a cross-feed of 0.015 inch. The wheel to be tested is 7 by 1/2 by 1 1/4 inches in size. After being mounted on the spindle, the wheel is dressed with a diamond to insure concentricity. The wheel diameter is then measured with a micrometer and the size recorded. A bar of Carboloy of proved quality, 5/16 by 3/8 by 2 1/4 inches, which has previously been weighed to the nearest gram, is placed on the magnetic chuck. As this Carboloy bar is only slightly magnetic, it is held in position by means of steel strips.

At every reversal of the cross-feed, the wheel is fed down 0.002 inch. The total down feed is 0.064 inch per bar, and the time consumed is approximately one hour. After this grinding test, the wheel is measured and the bar again weighed. This enables us to find the amount of stock removed in grams per 0.001 inch of wheel wear. The Carboloy bar is then broken in an Amsler testing machine to determine the strength of the Carboloy after grinding. The breaking test is known as a cross-breaking or rupture test, and is calculated in pounds per square inch.

All our grinding tests are run dry. It is our belief that dry grinding of flat work held rigidly on the machine table is the most hazardous of our grinding operations, and is also the method most commonly used. The test was devised with this in mind, and wheels that prove satisfactory in this test can be used without hesitation on our regular shop work. The results of the test also serve as an excellent guide in the selection of wheels for our other operations, such as wet grinding, circular grinding, form-tool grinding, hand grinding, etc.

Our experience has been that a wheel which re-

Tests Showing that Soft Wheels Must be Used to Avoid Injury to Carboloy Tools

Wheels	Stock Removed per 0.001 Inch of Wheel Wear	Strength of Carboloy after Grinding*	Appearance of Bar before Etching	Appearance of Bar after Etching
Suitable Wheel	0.0335	217,000	Good	Good
Suitable Wheel	0.0230	223,000	Good	Good
Unsuitable Wheel	0.0920	28,000	Good	Very distinct cracks
Unsuitable Wheel	0.0562	37,500	Good	Very distinct cracks

*This is the cross breaking or rupture strength, in pounds per square inch, obtained by breaking the ground Carboloy test pieces in an Amsler testing machine.

moves considerable stock in proportion to wheel wear is very detrimental to Carboloy. The figures given in the accompanying table will bring this fact out quite clearly. The best criterion of our test method is that since its inception our rejections due to cracked tools have dropped to a negligible quantity. Naturally, the improvement is not due wholly to the proper selection of wheels, as there are other factors that have also been improved; but the wheel selection is the most important of these factors.

In view of our experience, we advise users who are grinding their Carboloy tools to use extremely soft rather than hard wheels. The wheel cost may be somewhat higher, but it is our experience that the better and more consistent performance of the tools will more than pay for the higher wheel cost.

Some Results Obtained Through the Use of the New Cutting Alloys

In the Ransom Grinding Machine Co.'s shop in Oshkosh, Wis., tungsten-carbide tools have been used to advantage on work that would not ordinarily be considered as in the high-production class. The company had some difficulty in maintaining the size of holes bored in gray iron castings. The holes were bored 5 inches in diameter and 3 inches deep in a turret lathe, using a pilot-bar. It was desired to hold the size within 0.0002 inch. The finishing cut removed from 0.008 to 0.010 inch. The high-speed steel tools used wore rapidly and had to be resharpened and reset frequently.

Tungsten-carbide tools have made it possible to complete several hundred parts without resharpening; in fact, it is not yet known when resharpening will be required. The turret lathe has also been speeded up from a cutting speed of 80 feet per minute to 350 feet per minute.

In another machine tool plant, carbide tools are regularly used for heavy turning of cast iron at cutting speeds three times those ordinarily used. The columns of radial drills, sleeves, pulleys, and gears are regularly turned with these tools. Steel has also been turned successfully; the grades that can best be handled by the new tools are S A E 1045 and softer. On these steels, the cutting speed can be increased from 50 to 100 per cent, but it is often advisable to reduce the feed, as compared with the feed used with high-speed steel tools.

Carbide tools have also been used to considerable advantage for planing cast iron. For ordinary planing, the new cutting material is being used to an ever increasing extent. For chilled lathe beds, it has been found to be the best practice to use high-speed steel for the first roughing cut and carbide tools for the succeeding cuts.

A Valuable Report on Tungsten-Carbide Cutting Materials

An exhaustive investigation into the use of tungsten-carbide tools has been made by a committee of the American Society of Mechanical Engineers, the results of which are now available. A report of the investigation was presented by the chairman of the committee, Coleman Sellers, executive engineer of William Sellers & Co., Inc., Philadelphia, Pa., at the Society's annual meeting last December.

This report is based upon information obtained from eighty-five manufacturers throughout the country, and covers practically all phases of the application of tools made from tungsten carbide and other hard cutting materials. Typical examples showing savings due to the use of the new tools on engine lathes, turret lathes, automatics, and vertical boring mills are given in tabulated form in the report, which may be obtained from the American Society of Mechanical Engineers, 29 W. 39th St., New York.

Lapping of High-Speed Steel Tools

It is of interest to note that the introduction of carbide tools has had a marked influence on the application of high-speed steel tools. It has promoted the adoption of more careful and precise methods in machining operations. The new carbide tools fail if they are applied by hit-and-miss methods. No mere guesswork is permissible. High-speed steel tools will also give much better results if they are applied with greater thought and care.

One idea that has been brought out more forcibly because of the application of carbide tools is the fact that these tools will work to best advantage only when they are lapped. However, lapping of a high-speed steel tool is just as important; it makes the tool work much better. When these tools are lapped to a high finish, in addition to being ground, much longer life and better finish on the work are obtained.

* * *

A New Stellite with Remarkable Cutting Properties

The Haynes-Stellite Co. has recently developed a special grade of Stellite for cutting cast iron, malleable iron, semi-steel, and steel. This new cutting alloy, known as J-metal, when operating at the same speed, feed, and depth of cut as Stellite No. 3, will machine from two to four times as many pieces per grind. This new type of Stellite will operate at a maximum speed 30 per cent higher than grade No. 3, and at that speed will produce as many pieces per grind as grade No. 3.

SPEEDS AND FEEDS FOR CEMENTED CARBIDE MILLING CUTTERS—1

MACHINERY'S Data Sheet No. 225, New Series, May, 1932 Based upon recommendations made by the Kearney & Trecker Corporation

The speeds and feeds for cemented carbide milling cutters recommended in Data Sheet No. 226 are based on the experience of the Kearney & Trecker Corporation in the application of "full-back" tungsten- and tantalum-carbide milling cutters.

Selecting the Cutting Speed

The speeds recommended are based on the cutting characteristics of various metals and are safe speeds, but it may be necessary to modify them one way or another to suit particular cases. For instance, the speeds may be increased slightly when all conditions are favorable, as in the case of a rigid set-up, a free-cutting material, and a machine in good operating condition.

Under conditions not so favorable, it will be necessary to make a suitable reduction in the speed, as for instance, when the material is hard, the set-up is not rigid enough, and the milling machine is not in the best of condition. To determine how much speed the cutters will stand, start slowly and increase the speed gradually.

Selecting the Right Feed

The only satisfactory way to determine the feed per minute of a milling cutter is from the feed per tooth per revolution. Long experience with milling operations of all kinds has shown that the feed per tooth per revolution of a milling cutter has a direct relation to cutter life.

Too high a feed overloads the teeth of the cutter and very often causes breakage. With too fine a feed, excessive wear takes place, because the teeth have to pass in contact with the work more often than is necessary for a given length of cut.

Great care should be taken not to overload the machine. Sometimes a heavy set-up may be handled in a machine somewhat too light for the cutter, in which case the cutter should not be run at maximum feed. When the cut being taken is exceptionally wide, it is often necessary to reduce the feed per tooth per revolution to avoid overloading. A practical method of arriving at the proper feed for a given cut is to operate the cutter at the correct speed and apply as much feed as a combination of the cutter, the machine, and the work will stand without injury to any one of these factors.

Use of Speed and Feed Tables

The following example will serve to show the applications of the tables in Data Sheet No. 226. Find the feed per minute and the proper speed for a 5-inch cutter having 10 teeth, when rough-milling soft cast iron, taking a cut 1/8-inch deep.

In the table of cutting speeds, we find that 250 feet per minute is recommended for a cut of this kind. We next determine the number of revolutions per minute of the cutter by dividing the feet per minute by the circumference of the cutter in feet. Thus, we have 250 feet per minute divided by 1.31 feet equals 191 revolutions per minute.

Now, referring to the table of feeds, we find that the recommended feed per tooth per revolution for a cutter of this kind is from 0.008 to 0.010 inch. Assuming that the smallest feed would be best, we multiply the "teeth per minute" by 0.008 inch. The teeth per minute would be obtained by multiplying the number of teeth in the cutter by the number of revolutions per minute, which would be 10 times 191 equals 1910. Thus, we have 1910 times 0.008, which gives a table feed of 15.3 inches per minute.

SPEEDS AND FEEDS FOR CEMENTED CARBIDE MILLING CUTTERS—2

MACHINERY'S Data Sheet No. 226, New Series, May, 1932 Based upon recommendations made by the Kearney & Trecker Corporation

RECOMMENDED CUTTING SPEEDS FOR CEMENTED CARBIDE MILLING CUTTERS, FEET PER MINUTE

Material to be Milled	Roughing		Finishing
	Over 1/8-inch depth of cut	Under 1/8-inch depth of cut	Under 1/16-inch depth of cut
Cast Iron, soft	200– 250	250– 325	300– 400
Cast Iron, medium	150– 200	200– 250	250– 300
Cast Iron, hard	100– 125	125– 175	150– 250
†Malleable Iron	225– 300	250– 350	350– 450
†*Cast Steel	100– 200	150– 250	200– 300
†*Low-carbon Steel, soft	150– 200	175– 250	200– 350
†*Low-carbon Steel, medium	100– 150	150– 225	175– 250
†*Low-carbon Steel, hard	75– 100	100– 150	150– 200
Yellow Brass	300– 400	350– 500	400– 600
Ordinary Bronze	200– 300	250– 350	350– 500
†Aluminum	800–1200	1000–1500	1500–2000

†Use Coolant *Tantalum Carbide Cutters

RECOMMENDED FEEDS FOR CEMENTED CARBIDE MILLING CUTTERS IN INCHES PER TOOTH PER REVOLUTION

Material to be Milled	Roughing Depth 1/8-3/16 inch	Semi-finishing Depth 1/16-1/8 inch	Finishing Depth 1/16 inch or under
Cast Iron	0.008–0.010	0.009–0.014	0.006–0.008
Malleable Iron	0.008–0.010	0.009–0.014	0.006–0.008
Brass	0.010–0.012	0.012–0.016	0.008–0.010
Bronze	0.010–0.012	0.012–0.016	0.008–0.010
Aluminum	0.004–0.007	0.005–0.007	0.003–0.006
Steel	0.004–0.008	0.005–0.009	0.003–0.006

Decrease finishing feeds if greater smoothness of surface is desired.

The *feed per tooth per revolution* equals the feed per minute, in inches, divided by the number of teeth in the cutter, multiplied by the number of revolutions per minute.

The *feed per minute* equals the feed per tooth per revolution multiplied by the number of teeth in the cutter, multiplied by the number of revolutions per minute.

Dial Gage for Bores of Bushings and Sleeves

By W. C. BETZ, Master Mechanic, The Fafnir Bearing Co.
New Britain, Conn.

The bores of sleeves, bushings, gears, and other parts of a similar kind that are made in large quantities can be gaged rapidly and accurately with the dial gage shown in Fig. 1. The gage consists of six main parts. The contact end *A*, which is bored to receive plunger *C*, is turned down on the end to allow it to enter the work when the bore is still a little under size. This end has three holes for the steel balls that serve as contacts on the bore to be gaged. These holes are "cherried" out from the inside by slipping the shank of the cherrying tool *C*, Fig. 2, through the open end of the part *A*, Fig. 1, and fastening the shank in the chuck of a small drill press. The wall is thus reamed out to the depth of the shoulder *D*, Fig. 2. The recesses produced serve to keep the balls from falling out.

The sleeve *B* operates the plunger *C*, which has a tapered end that controls the dimension over the balls that gage the bore. One face of the work is kept in contact with the sliding sleeve *D*, so that the points of contact of the balls are in a plane located at right angles with the center line of the work. This permits the gage to detect any taper in the bore. The dial indicator is held in place by the clamp *F*, shown in Fig. 2. This clamp grips the tube of the indicator and holds it securely in place.

The eyed lug on the back plate of the indicator should be sawed off, and the case smoothed so that it will present a good appearance. The taper on part *C* should be ground to suit the requirements of the job. For direct reading on dials graduated to 0.001 inch, the taper on part *C* should have an included angle of 53 degrees 18 minutes. If readings to 0.0001 inch are required, the included angle should be 5 degrees 44 minutes, or 0.001 inch of taper for each 0.010 inch of travel of the plunger *C*.

In use, sleeve *B* is pushed toward the contact end of the gage as far as the stop-pin on part *C* will permit. This allows the contact balls to drop into the recess at the neck of part *C*, so that the end *A* is easily inserted in the bore of the work. On releasing sleeve *B*, the spring *S* carries both members *B* and *C* back toward the dial indicator, where the end of the plunger makes contact with the dial gage

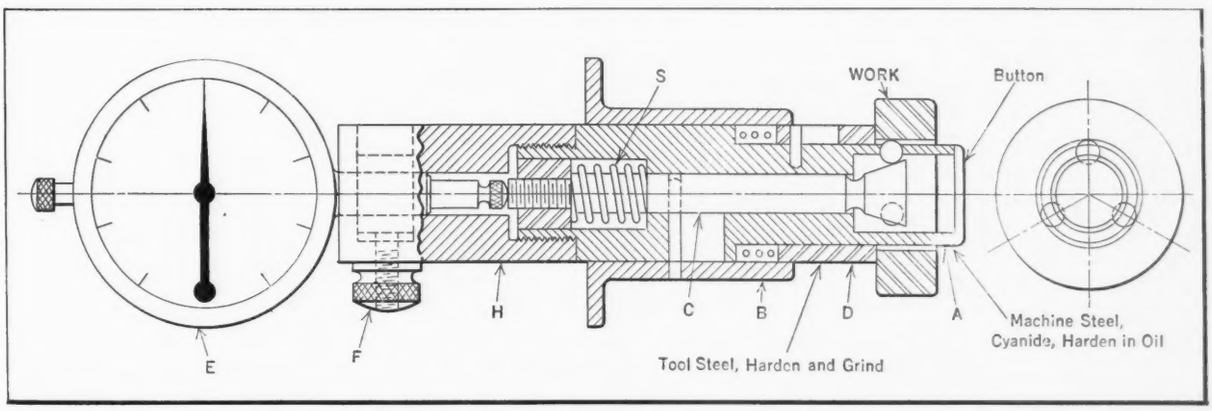


Fig. 1. Assembly View of Dial Gage for Inspecting Bore Diameters

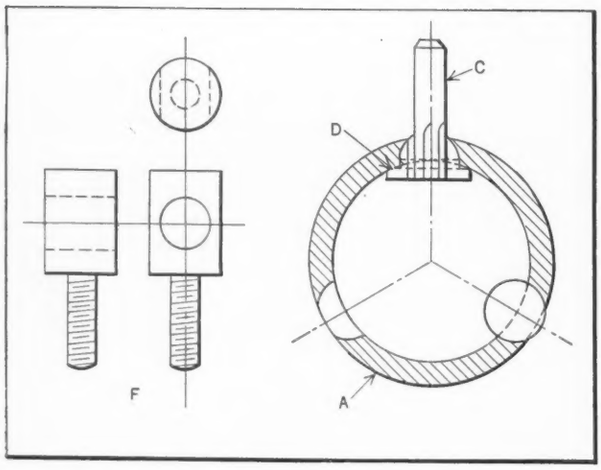


Fig. 2. Details of Part F and the Cherrying Tool C for Machining Ball Recesses

and registers the size. Plus or minus limits are accurately gaged by setting the indicator to read zero on a master ring of the correct size. The taper on the work is determined by sliding the gage back and forth within the limits of the travel of sleeve *D*.

Equipping Tubular Riveting Machine for Securing Nameplate

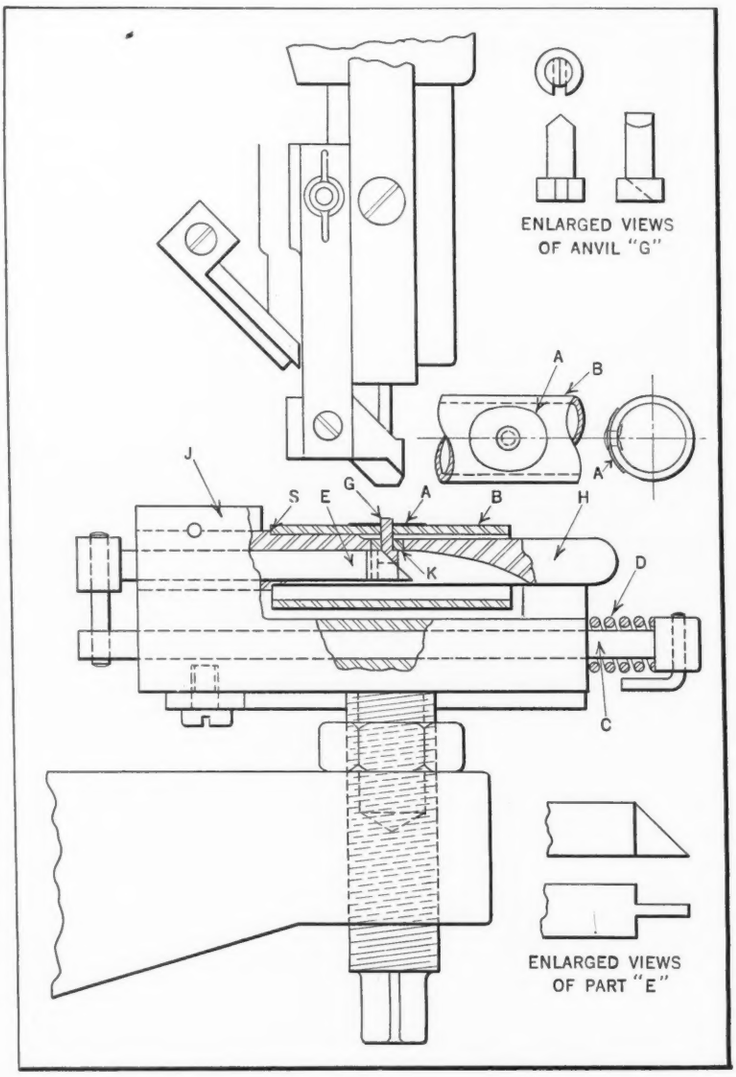
By E. L. SOLTNER, Tool-room Foreman
Mitchell Specialty Co., Holmesburg, Pa.

A tubular riveting machine equipped with a fixture such as shown in the accompanying illustration provides an efficient means for securing a disk-shaped nameplate to a tubular part. In operation, the shaft *C* is pushed inward against the thrust of spring *D*. This withdraws the plunger *E* from under anvil *G*, allowing the anvil to drop to the bottom of the hole in the horn *H*. The construction of the anvil *G* is shown in the enlarged view in the upper right-hand corner of the illustration. The shaft on the end of plunger *E* that actuates anvil *G* is shown by the two enlarged views in the lower right-hand corner.

With the plunger *E* held in the rear position, the work *B* is slipped over the horn *H* and located against the shoulder *S*. This brings the hole in the work into alignment with the anvil *G*, which, under the action of spring *D*, snaps through the holes in the work pieces *A* and *B* when shaft *C* is released. In this position, the anvil is ready to guide the rivet into its proper position when the machine is tripped by the operator. As the ram of the riveting machine descends, the rivet is carried down by the riveting punch and impaled upon the anvil which guides it through the holes in the work. When the anvil strikes the bottom of the hole in the horn, the rivet is upset. The anvil maintains this position until the work is removed. Then, under the action of the spring, shaft, and plunger, it returns to the raised position.

One of the features of this fixture is the shape of the anvil shown in the enlarged view. It will be noted that the rivet end of the anvil is angular. The apex of this angular end is located parallel to the center line of the horn *H*. This permits the work to be easily removed from the horn.

To guard against the work becoming locked behind the anvil, the center line of the anvil is located 0.010 inch behind the center line of the rivet. This is necessary, as the anvil and rivet are of the same diameter and the parts closely fitted. It was found necessary to make the angular tongue of plunger *E* and the slot in the anvil very smooth and free from tool marks, in order to have the fixture operate smoothly. It was also necessary to make



Fixture Employed on Riveting Machine for Securing Nameplate A to Tube B with Tubular Rivet

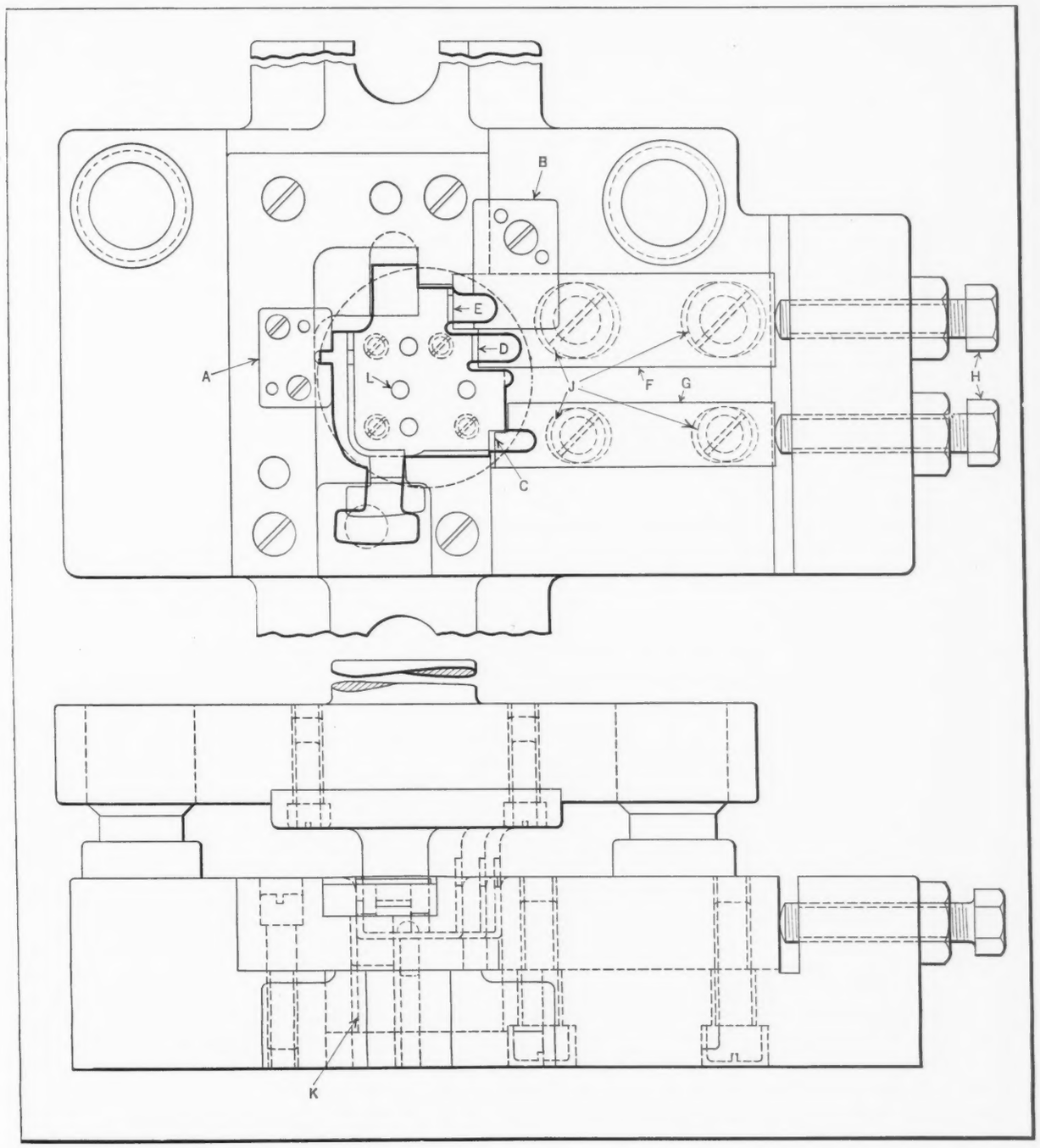
the anvil a close slip fit in the bushing *K*. The parts were so designed that the angular tongue of plunger *E* is always engaged in the slot of the anvil *G*, so that the angular end of the anvil is always parallel with the horn. All parts of this tool are made of tool steel.

Forming Die with Adjustable Members

By E. F. EBERHARD, Bridgeport, Conn.

Typewriter parts made in power presses require the use of dies designed not only to give rapid production, but also to maintain a high degree of accuracy in the parts. In the illustration is shown a good example of the type of forming die that meets these requirements. This die is of the pillar type to insure accurate alignment of the die members with the punch. Although the punch is made solid, the die members are of the built-up construction for reasons of economy. With this type of construction, it is also possible to shim up certain members to compensate for wear.

The blank formed in this die is of an unusual shape. It is a finger piece on the carriage end of a typewriter, and has three separate right-angle



Compensation for Wear of the Forming Surfaces in This Die is Obtained by Adjusting the Forming Bars F and G

bends, together with a corner bend. Projections on the blank enter grooves cut in the stationary nests *A* and *B*, and together with the pilot pin *L*, locate the blank on the spring pad *K*.

Special provision is made for adjusting the die for wear at the points *C*, *D*, and *E*. This adjustment is obtained by means of the sliding bars *F* and *G*. As the ends of these bars are worn by the forming operation, they are moved toward the left by means of the screws *H*, after which they are locked securely in position by the screws *J*.

One feature worthy of mention is that the heads of screws *J* are sunk in the bottom of the die. This is done to prevent the operator from changing the adjustment after it has once been made. All four bends are made at one stroke of the press, the formed piece being ejected by the spring pad *K*.

The die formerly used for this work was of a solid construction, but because of the great amount of wear on the forming edges, its life was very short. With the present die, however, this difficulty was overcome.

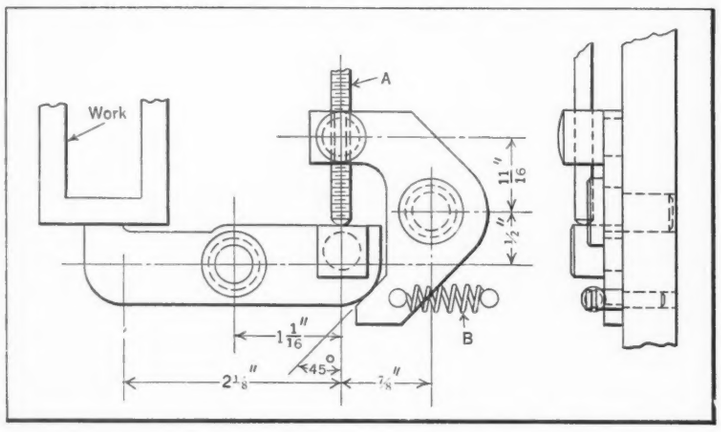
Constant-Pressure Clamp

By FRED J. SANDERS, Dayton, Ohio

The clamp shown in the accompanying illustration is designed to exert a constant pressure on the work, regardless of how tight the thumb-screw *A* is turned or whether the parts vary in size. A clamp of this type is often required when a very frail part is to be located in a drill jig or fixture or when a varying pressure of the screw would affect the location of the part.

The amount of pressure to be exerted on the part can be increased or diminished by changing the 45-degree angle. A more obtuse angle will increase the pressure and a more acute angle will diminish it. The pressure can also be controlled by moving the fulcrum point of the clamping lever.

The light spring *B* serves to keep the clamping lever engaged with the work. When loading and unloading the jig or fixture, the screw *A* is pulled backward, causing the clamping lever to pivot or swing away from the work.



Clamp Designed to Prevent Exerting Too Much Pressure on Frail Parts

Calculating Gear-Shaft Centers for Jig-Boring Operation

By C. W. HINMAN, Tool Designer, Kobzy Tool Co. Chicago, Ill.

In the illustration is shown a lay-out of the bushing holes in a jig employed for drilling and reaming three gear-shaft holes in a gear-box. The bushing holes are bored in a jig-boring machine and for that reason, the dimensions *X*, *Y*, and *H* must be calculated.

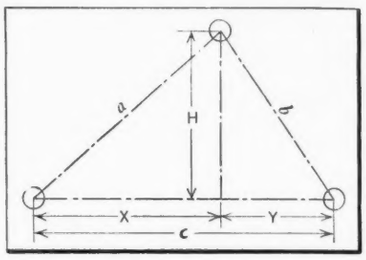


Diagram for Calculating Gear-shaft Centers

Formulas for doing this are available in some of the engineering handbooks, but the writer, in endeavoring to obtain a short-cut method, developed the following formulas:

$$X = \frac{a^2 - b^2 + c^2}{2c}$$

$$Y = c - X$$

$$H = \sqrt{a^2 - X^2}$$

For example, if $a = 10$ inches, $b = 8$ inches, and $c = 12$ inches, then

$$X = \frac{100 - 64 + 144}{24} = 7\ 1/2 \text{ inches}$$

$$Y = 12 - 7\ 1/2 = 4\ 1/2 \text{ inches}$$

$$H = \sqrt{100 - 56.25} = 6.614 \text{ inches}$$

[Other simple solutions of this problem, together with a selected collection of mathematical and drafting-room problems, may be found in MACHINERY'S "Draftsman's Mathematical Manual."—EDITOR]

* * *

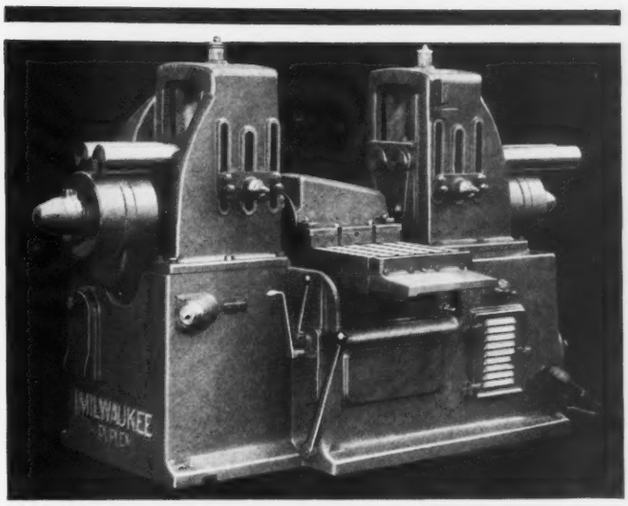
Monel Metal Shaft of Unusual Size

At a recent exhibition, a monel metal shaft 6 inches in diameter and 14 feet long was shown by the International Nickel Co. This shaft weighed 1534 pounds and was forged from a solid monel metal billet weighing over 2000 pounds. Tests showed that the material from which the shaft was made had a yield point of 76,310 pounds per square inch and an ultimate breaking strength of 100,875 pounds per square inch. A high ductility was shown by tests—27.5 per cent elongation and 57.3 per cent reduction of area in a two-inch specimen. Monel metal will not rust in either salt or fresh water, and hence is of especial value in the construction of marine equipment and devices likely to be subjected to the action of either fresh or sea water.

Milling with Carbide Insert Cutters

Both Tungsten- and Tantalum-Carbide Milling Cutters Have Effected Such Material Savings that an Ever-Broadening Field of Application is Assured—First of Two Articles

By FRANK W. CURTIS, Research Engineer
Kearney & Trecker Corporation, Milwaukee, Wis.



WHILE it is generally recognized that the tungsten- and tantalum-carbide alloys have proved that they can be used successfully for turning, there are many who believe that the application of these cutting materials in milling practice is somewhat doubtful. Let us therefore say at the outset—and prove our case as we go along—that the carbide tools have passed the initial experimental stage, even for milling operations. Their application to milling cutters is not only practicable, but practical.

It is obvious that there is much research work still to be done, but at present, enough is known on the subject to predetermine with fair accuracy what can be accomplished by the use of the new tool materials. Progressive manufacturers are therefore justified in beginning immediately to apply carbide alloys to milling operations. It takes some time for a plant to become acquainted with the characteristics of these new materials and to train operators in their use, and it is wise to make the start now; because of the possibilities of these new cutting materials there is no doubt. They offer in many instances unparalleled means of doing *more* work *better*.

Up to the present time, most carbide alloy milling operations have been performed with inserted-blade cutters, such as face mills and side mills, for finishing flat surfaces. The new materials can, however, also be applied as inserts in solid type cutters, such as are used for milling keyways, slots, or grooves, and for similar operations. The latter applications, however, are still of minor importance. In the following, the expression "tungsten carbide" will be used, but it should be understood that, when speaking in general terms, tantalum-carbide cutters are included.

A PROGRESS RECORD IN THE ART OF CUTTING METAL

There are many advantages to be gained by the use of tungsten-carbide milling cutters. First, there is greater output, due to the higher speeds and faster feeds that can be used. In addition, it is usually possible to obtain longer cutter life between grinds. The life varies with the nature of the work being milled, but in most cases where tungsten-carbide cutters are applicable, the life is at least double that of cutters made from high-speed steel.

Second, greater accuracy and improved finish are obtained. Far less heat is generated on the face of the work being milled, so that there is a minimum of distortion. On most tungsten-carbide milling, if correct speeds are used, the work hardly changes at all in temperature.

Third, on many classes of work less allowance is required for the finish cut. Quite often this allowance on cast-iron parts has been reduced to one-half of what was formerly necessary. The reason for this is that tungsten carbide is not affected seriously by the scale on the casting, provided the piece itself is not too hard. Hence it is feasible to reduce the depth of cut to a point where the casting will simply "clean up." This means a decided saving in material costs.

Because of the ability to reduce the amount of stock to be removed, it is often possible to combine roughing and finishing cuts. Frequently the surface so milled will be equal in finish, if not better, than a surface milled in two cuts. This combination of roughing and finishing cuts is practiced successfully in many plants today.

An example of milling that indicates the saving made by reducing the allowance for finishing is shown in Fig. 1. On these cast-iron motor plates, formerly 1/4 inch of metal was removed. Now, with tungsten-carbide cutters, only 1/8 inch is taken off. The cutter is 6 inches in diameter and operated at 283 feet per minute. The feed is 17 inches per minute. The cutting time has been reduced more than 30 per cent. This is due to the fact that the surface is now finished in one cut instead of in two, as was formerly the case. Another advantage of the use of tungsten-

carbide milling cutters is that there is less likelihood of the corners of the cutters becoming chipped. Usually, the feed per tooth per revolution of tungsten-carbide cutters is reduced slightly, compared with that required for former tools. This, combined with a high cutting speed, reduces the cutting strain on the casting, so that the corners are not so likely to break away.

The Reduced Cost of Subsequent Operations is an Advantage not to be Overlooked

Besides the direct advantages mentioned, there are several indirect savings due to the use of the new cutting materials. One of these has been mentioned—the decreased amount of stock allowed for

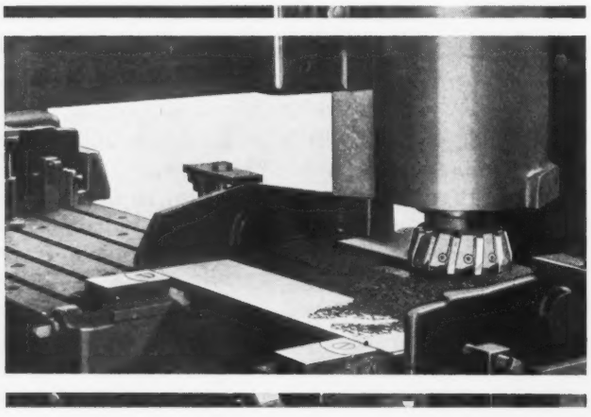


Fig. 1. Milling Cast-iron Motor Plates with Tungsten Carbide Tipped Milling Cutters

finishing. Another saving is due to the fact that the cost of subsequent operations may be reduced.

For example, when a bearing surface has to be scraped after milling, it is often possible to save much of the scraping time, because of the better finish of the milled surface. In the Kearney & Trecker shops, the scraping time on flat surfaces has been reduced approximately 50 per cent. This is due largely to the smooth true surface obtained by milling with tungsten carbide. In another plant, scraping and grinding operations on flat surfaces have been entirely eliminated by the use of the new milling cutters.

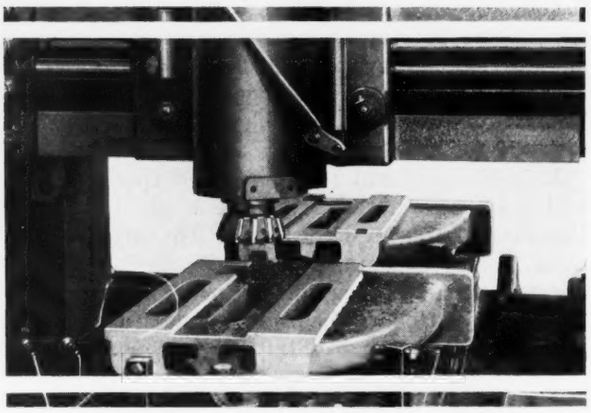
An example of such saving may be mentioned: Small cast-iron pump bodies formerly required rough- and finish-milling, followed by scraping, to produce a water-tight surface. The total time for these operations was 18 minutes. By the use of a tungsten-carbide cutter, the surfaces are now finished in 2 minutes, and no scraping is required.

In some instances, tungsten-carbide milling has taken the place of disk grinding, in which case scrap metal in the form of chips may be saved. When abrasive dust is objectionable on finished surfaces, it is possible to eliminate a washing operation by substituting milling for grinding.

Can Tungsten-Carbide Milling Cutters be Successfully Used in Present Machines?

Even though the good milling machines of yesterday do not perform as well as the modern machines that have been designed for high-power milling, there are hundreds of operations now being successfully performed on milling machines that were not specifically designed for tungsten-carbide operation. The application of the new cutters has resulted in greater production. The machines are not necessarily overloaded or subjected to undue strains. However, the milling machine must be of fairly recent manufacture and in first-class operating condition; and in no case are the results as favorable as they would be with a heavy modern

Fig. 2. Milling Uprights of Milling Machines—an Example of the Profitable Use of the New Cutters in Milling Small Quantities



machine that meets the requirements of the new cutters. Old machines in poor condition should never be used with tungsten-carbide cutters.

An Example of Actual Savings

As a specific example of savings made possible through the use of the new cutters, the following case is cited: A milling machine of good design and in first-class condition, but several years old, is used for milling cast-iron meter bodies in a mid-western plant. A 6-inch carbide cutter, operated at a feed of 26 inches per minute and removing approximately 1/8 inch of material, is used. Previously, the table feed was 13 inches per minute, the cut requiring 60 seconds. The table traverse and the loading consumed 30 seconds, so that the complete cycle was 90 seconds. By doubling the table feed through the use of carbide cutters, the production was increased 50 per cent, floor-to-floor time. Formerly, 400 pieces were produced in a ten-hour day; now 600 are completed.

The 200 additional pieces produced are equivalent to five hours' production with former cutters. With a labor saving of 60 cents per hour and a burden saving of $1.50 per hour, the saving per day is $10.50.

Heretofore it was necessary to grind the cutters for every 200 pieces. This took 30 minutes. The tungsten-carbide cutter is ground for every 600 pieces. When dull, it requires 45 minutes for reconditioning. For every 600 pieces, then, there is a saving of 45 minutes for cutter sharpening. This, with grinding at $1.50 per hour, means a saving of $1.12, making a total of $11.62 for every 10-hour day. The cutter cost $181, and hence pays for itself through the savings made in less than sixteen days.

The question is often asked: "How many parts are required to make the new cutters profitable?" This is a difficult question to answer, because so much depends on individual shop conditions. In the Kearney & Trecker plant, it has been found advantageous to use a tungsten-carbide cutter even when only one piece is being milled. This is because the operators are trained in the use of these cutters and prefer them. They are able to produce a smoother finish and more accurate work. Also, in many instances, the parts milled have to be scraped afterward; this operation, as already mentioned, consumes less time when the milling operation is performed with tungsten-carbide cutters.

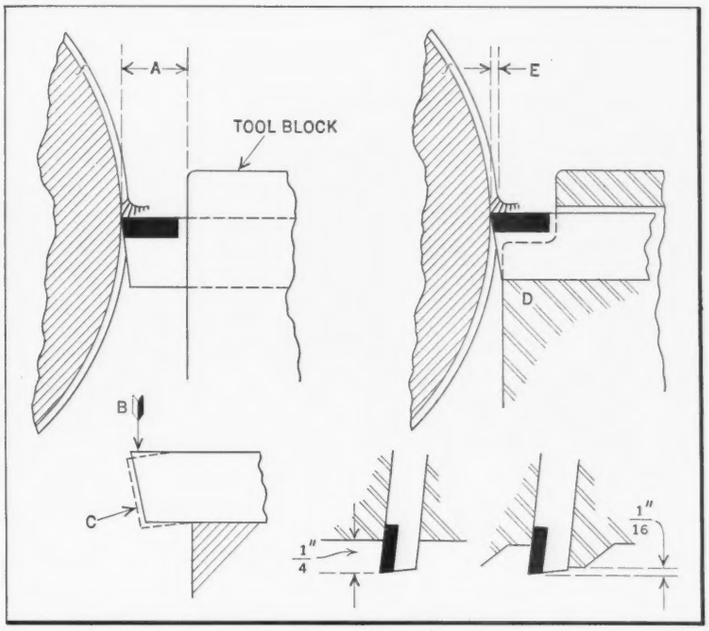


Fig. 3. Illustrations Indicating the Importance of Small Overhang of Tungsten-carbide Tools

An example of small-quantity milling is illustrated in Fig. 2, which shows the milling of uprights for milling machines. Formerly, this operation was done with a large cutter that finished both surfaces at one pass. Now a smaller tungsten-carbide cutter is used that finishes first one side, and then, after the head is adjusted and the table reversed, the other side. On this operation it has been possible to reduce the cutting time over 40 per cent.

The Cost of the Cutter is Not Always the Deciding Factor

Tool cost should not always be the deciding factor in determining whether or not tungsten-carbide milling should be used, because the other savings referred to frequently offset the slight addition in tool cost per piece. For example, in milling the meter bodies previously mentioned, the cutter cost of $181, divided over a period of sixteen days, would equal 1.9 cents per piece, based on a production of 600 pieces per day. Obviously, this tool cost per piece might be excessive in many cases, but inasmuch as the savings in labor cost and burden permitted the cutter to be paid for in sixteen days, it is obvious that the tool cost per piece is not the only factor to be considered. It must be thought of only in connection with the savings obtained in other directions.

When tungsten milling is used for operations where the outstanding gain is the increased output per day, it is obvious that the operator will have to work proportionately harder. For this reason, it is well to provide some form of compensation for the operator, because, after all, it is to him that we have to look for success. Some might be prejudiced against the new cutters because they would have to work harder, and might try to discredit the new tools; but if the operator gets a bonus on the increased production, he will be anxious to make tungsten-carbide milling successful. Letting the operator share in the savings will ultimately result in greater success for the new method and will make the operator an important factor in its success.

When Failures are Met with, Do not Condemn the Process, but Learn by the Experience

Failures in the use of tungsten-carbide milling cutters are bound to occur from time to time, but there is usually a good cause for every failure. If the difficulty is analyzed, it is likely that something can be learned through the failure that will prove of value later on. It might also be said that failures and accidents happen with all kinds of cutting materials, especially when they are not properly applied. It is therefore of particular importance to understand the conditions under which tungsten-carbide tools may be expected to give good results.

Having now dealt with the advantages and the general underlying principles of the application of tungsten-carbide milling cutters, we will take up in somewhat greater detail a few of the important points to be observed in the successful application of the new cutters.

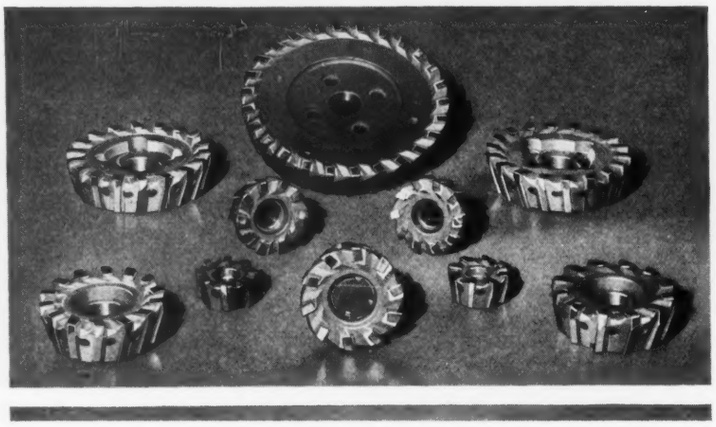


Fig. 4. A Collection of Cutters with Inserted Tungsten-carbide and Tantalum-carbide Blades

Better milling fixtures are required, because in many instances, traditional methods are inadequate. Fixtures for tungsten-carbide milling should preferably be of the semi-automatic type in which the alignment, locating, and clamping of the work-piece is actuated by a single handle. Rigidity is of prime importance. It has been said that the fixture should first be designed as strong and husky as judgment dictates, and then 50 per cent should be added as a margin of safety. The additional metal in the fixture is a small item of expense.

Sometimes it is stated that faster milling is of no advantage, because the operator is not able to load the work any faster. Such a remark merely means that an analysis should be made of the present method of handling the work, with a view to introducing faster and better methods. Primarily, the fixture design needs to be improved.

The importance of rigidity when using tools tipped with tungsten carbide has been stressed. Let us examine into the reasons for this. Any overhanging member has an amplitude of vibration that varies with the length of the overhang. Twice the length of overhang will increase the vibration eight times; four times the length of overhang, sixty-four times.

In Fig. 3 is shown a lathe tool with the overhang ordinarily used in conventional turning methods indicated at *A*. This method of supporting the tool is unsatisfactory, no matter what the tool material, but it is especially objectionable with tungsten-carbide tools, because the pressure of the cut on the top of the tool causes deflection and vibration,

Don'ts to be Observed in Milling with Tungsten- and Tantalum-Carbide Cutters

Don't stop the spindle without first disengaging the table feed. Stopping in the cut subjects the cutting edges to severe strains that may damage the cutter.

Don't feed the cutter back over a milled surface with the spindle stopped. The drag may injure the cutting edge.

Don't use the rapid traverse to bring the cutter up to the cut with the spindle stopped. The trip-dogs may not be set accurately or there may be a variation in the length of the parts being milled, so that the tungsten-carbide tip would be injured by being forced into a solid obstruction.

Don't operate the cutter if there is vibration. Try to find whether the cause is in the machine or the fixture. If the trouble cannot be corrected, do not attempt to use carbide cutters.

Don't use a carbide cutter on work that is not held securely. If it becomes loose in the fixture, it will ruin the cutter. The holding means must be positive.

Don't run a carbide cutter backward by mistake. This may seem an unnecessary injunction, but many cutters have been ruined by it. The spindle, when milling with small tungsten-carbide cutters, rotates so fast that the direction of rotation is not always obvious to the eye.

as indicated at *C*, where the tool has deflected under the pressure of force *B*. Sometimes the amount of deflection is extremely small, but the vibration that results may nevertheless cause tool failure.

By lessening the overhang through the addition of a support at *D*, the unsupported projection of the tool is reduced to *E*. This amount is about one-fourth that shown at *A*, which means that the tool will have sixty-four times less deflection. In the lower right-hand corner of the illustration are shown the same conditions applied to a milling cutter blade.

A group of carbide insert milling cutters designed to give proper support to the blades is illustrated in Fig. 4. The blades are set almost flush with the body. Chip clearance is provided by grooving the body in front of each blade. This construction gives adequate support to the full back surface of the blade.

The precautions given in the accompanying "Don'ts" apply equally to all kinds of cutters, whether made from tungsten carbide, Stellite, or high-speed steel. Whatever assures success in tungsten-carbide milling will improve the performance of cutters made from any other cutting material, but the rules are more important when applied to the new tools, because they are more easily injured by careless handling and the cost of an accident is much greater.

Milling machines especially suited to tungsten-carbide operation also make it possible to obtain more effective and economical results when using other cutting materials on work where tungsten carbide cannot be used to satisfaction—for example, on such operations as small end-milling, intricate form cutter work, the milling of T-slots, small keyway milling, etc.

In the second installment of this article, to be published in June MACHINERY, the grinding of tungsten-carbide milling cutters and the milling of aluminum, cast iron, and steel will be dealt with.

* * *

It is well to plan carefully; but it is equally important to carry out the plans.

Electric-Arc Cutting "Saw"

Metal bars, shapes, and similar parts can now be cut by means of a rapidly rotating disk wheel through which a current of electricity flows. This wheel, which is manufactured by the Electric Arc Cutting & Welding Co., Newark, N. J., is shown in operation in the illustration. Among the materials used for these wheels are carbon and different forms of abrasives. The wheel forms one electrode and the work to be cut the other electrode. Consequently, when the work is fed against the wheel, the arc produced melts the metal and allows the wheel to pass through the work.

Electric-arc "Saw" for Cutting Metals. The Disk and the Work are the Electrodes

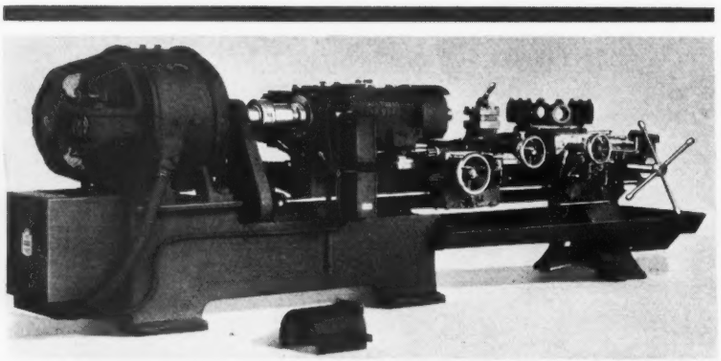
The advantage of the rotating electrode is that a new cool section is constantly being presented to the work and the molten metal is immediately carried away, leaving an unusually even cut. The wheel never wears out, but builds up. This necessitates the removal of the added metal by shaving the wheel at intervals. Wheel speeds above 1800 revolutions per minute are recommended, and a belt drive should be used to prevent damage in case the wheel binds in the cut.

This is an interesting application of the electric current in machine shop work, and indicates the ever broadening field for electrical equipment on operations for which mechanical means were formerly considered the only ones that were practicable.

* * *

Working under the direction of Dr. E. F. Northrup, vice-president and technical advisor of the Ajax Electrothermic Corporation, Trenton, N. J., and using a furnace of the Ajax-Northrup inductor type, Frank T. Chesnut, electrical engineer of the corporation, has been able to produce a controlled temperature of 3600 degrees C. (approximately 6500 degrees F.). The method was developed especially for the graphitization of waste coke products. Other practical uses suggested are in the vaporization of metals, and the manufacture of carbide cutting tools.

The Machine Tool Industry and the New Cutting Tools



A Review of Some of the Effects of the New Cutting Materials on the Design of Machine Tools of Different Types

TO what extent the newly developed carbide cutting tools have affected machine tool design is an interesting question; obviously, to use these tools effectively, great power, high speeds, and unusual rigidity are required. In the present article, the opinions of a number of machine tool builders and engineers as to the effect of the new cutting tools on machine tool design have been gathered. In addition, results obtained in the practical application of these cutting tools are recorded.

Engine Lathes are Already Available that Meet All Requirements of the New Tool Materials

In answer to the question, What effect have the new carbide tools had on lathe design? one leading lathe manufacturer said: "The effect has been almost revolutionary. I believe that it is fitting to use that word when one considers that lathes for which 5-horsepower motors were ample in the past, are now provided with 20-horsepower motors, if intended for production work using the new carbide tools. At least three times the previous power requirements are now necessary. A 10-horsepower motor on a 16-inch lathe or a 20-horsepower motor on a 20-inch lathe is not too much.

"In addition, provision must, of course, be made for higher speeds. Up-to-date designs of lathes are capable of about three times the speed of former designs. This means first of all that better bearings must be provided, preferably roller bearings in the head, gear-boxes, and tailstock spindle. The higher speeds also require better lubrication means and better materials in the machines.

"The greater rigidity required means heavier cross-sections in the beds, heavier tool-rest and carriage, and improved tailstock design. At high speeds there is the danger of burning out the tail-centers. Roller-bearing tailstock spindles eliminate this difficulty.

"Special provision must be made for the chips removed by the carbide tools. Big chip pans and open construction of the bed meet this requirement. These improvements are not ideas to be incorporated in future designs; they are already incorporated in up-to-date lathe designs. Progressive machine tool builders have been alert to meet the new requirements. In fact, I believe that the machines are now ahead of the tools; but, of course, we may expect marked improvements in the carbide tools in the near future."

Another leading manufacturer of lathes recognizes the great effect that the new cutting tools will have on lathe design, but regrets that some of the early claims for the carbide tools may have retarded rather than accelerated the normal development in machine tool design to meet the requirements of the new tools. Machines with excessively high speeds, this manufacturer thinks, are not called for at the present time. Both the new carbide materials and the machines best adapted for their use will have to go through a trial period much the same as the high-speed steel tools and the machines suitable for their effective use did some twenty-five years ago. The final results cannot be recorded until this trial period is completed.

Tungsten-Carbide Tools have been Applied Successfully to Turret Lathes

Two articles relating to the application of the new cutting tools to turret lathe work will be found on pages 655 and 671 of this number of MACHINERY, expressing the views of two leading companies in this field. Another turret lathe manufacturer, the Acme Machine Tool Co., Cincinnati, Ohio, states that the introduction of tungsten-carbide tools has not yet had a very marked effect on the design of turret lathes. Spindle speeds have been increased, but this was not difficult in the case of machines that were already so designed that spindles and driving shafts were equipped with anti-friction bearings. In that case, the only definite change required was a larger motor to provide for the increased power requirements.

Recently, this company built a No. 1 universal turret lathe with a special drive adapted for tung-

sten-carbide tools, as shown in the heading illustration. A 25-horsepower variable-speed motor was coupled directly to the spindle. The maximum spindle speed is approximately 1600 revolutions per minute, the gearing in the head being entirely eliminated. This machine was built to the customer's specifications. The machine is used for machining bronze bushings that are rough- and finish-bored, turned, and cut off.

A PROGRESS RECORD IN THE ART OF CUTTING METAL

Automatic Lathes Adapted to Super-Hard Tools

Speeds from four to six times as fast as those required when high-speed steel is used will be found necessary in machines intended for tungsten-carbide tools, according to C. H. Rystrom of the John S. Barnes Corporation, Rockford, Ill. The vibration caused by these high speeds will necessitate entirely new departures in machine tool design. Several times the power input will be needed, chatter must be eliminated, and the number of gears reduced to a minimum. Feed motions must be uniform and positive, and there must be no backlash.

The automatic lathes with hydraulic feed recently brought out by the Barnes Corporation were built especially for the use of the new cutting tools. The hydraulic mechanism provides an even feed. On some of the machines there are only two gear contacts—pick-off gears for changing speeds, and herringbone gears for the main spindle drive. In one model, the drive is from the motor direct to the spindle. Bolts and screws are eliminated whenever possible, beds, bases, and headstocks being cast in one piece.

Detailed data referring to a number of production jobs performed on Barnes automatic lathes may prove of interest. Part to be machined: Bearing cup of 4 per cent nickel, 1 1/2 per cent chromium steel, 200,000 pounds per square inch tensile strength before annealing. Operations: Rough-turning and facing in one cut. Material removed: 1/8 inch on each side; limits, plus or minus 0.0015 inch. Speed: 340 surface feet per minute; feed, 0.030 inch per revolution.

Part to be machined: Bushing made from SAE 64 phosphor bronze. Operations: Turning and facing. Speed: 1310 feet per minute on the outside of the flange; 1055 feet per minute on the outside of the body. Feed: 0.020 inch per revolution for roughing, and 0.015 inch per revolution for finishing cuts. (See Fig. 1.)

Part to be machined: Cylinder sleeve made from cast iron. Operations: Turning and facing. Speed: 200 to 275 surface feet per minute for roughing, and 275 to 350 for finishing. Feed: 0.025 to 0.035 inch per revolution for roughing, and 0.020 to 0.025 inch per revolution for finishing.

According to C. W. Simpson, manager of the National Acme Co., Windsor, Vt., many automatic machines have been made sufficiently massive since the introduction of the carbide tools and have spindle speeds high enough to accommodate them.

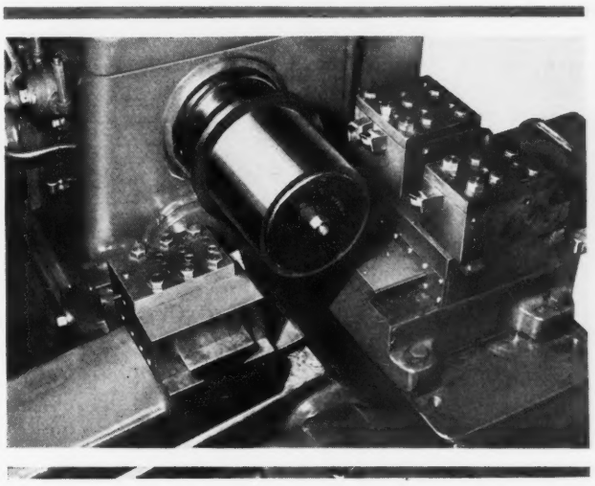
"Automatic turning machines of all kinds offer a valuable opportunity for the use of the new carbide tools," said Mr. Simpson. "On automatic machines, the lasting quality of the tools is, by far, the most important characteristic. The idea that the great savings due to the new cutting tools are accomplished by increased speeds does not always hold true. In the case of automatic machines, perhaps the main saving will result from the fact that the tools will seldom need regrinding, and hence the time lost in setting up and adjusting the machines after grinding is saved. Especially when working on cast iron, fiber, and rubber have the new tools proved very valuable."

One of the makers of the super-hard cutting metals believes that ultimately one of the most useful fields of application will be on automatic and semi-automatic machines.

Effect on Drilling Machines

As far as drilling machines are concerned, the present high-power drilling machines have ample capacity to handle any tungsten-carbide tools suitable for use in machines of this type. The modern radial drill, for example, has tremendous power capacity. Should the experiments made with carbide-insert twist drills prove successful, the only change that would be required in drilling machines of this type would be in the speed range. The strength of the design is adequate for the power required. Radial drills, for example, now provided with 10-horsepower motors have gear-boxes that could easily transmit 20 horsepower if needed.

Fig. 1. Tungsten-carbide Tools Used for Turning a Bronze Bushing in an Automatic Lathe



Boring Cylinders with Tungsten-Carbide Tools

Cylinder boring machines have been equipped for using tungsten-carbide tools to a

considerable extent. The Moline Tool Co., Moline, Ill., has used these tools for various applications, both in the company's own plant and in equipping boring machines for the automobile industry. The Nash Motors Co., reports on one of these installations that the company has been so well pleased with the results obtained with tungsten-carbide tools on cast iron that practically all cast-iron and malleable parts are to be machined by the new cutting tools.

In boring cylinders, it was found that before the first regrinding, twice the number of pieces were obtained with tungsten-carbide tools as with tools previously used. The same proportion held true for the second regrinding, but previous to the third, fourth, and fifth regrindings, from four to five times as many pieces were obtained with the tungsten-carbide tools as had been formerly possible.

In the Moline Tool Co.'s plant, cylinder sleeves are made from a very hard alloy iron that formerly could not be machined with steel tools. Tungsten-carbide tools, however, machine them quite readily. This company emphasizes the value of a heavy tool-holder and support as the most important factor in the successful use of the new tools.

Three articles appear in the present number, on pages 650, 665, and 685, pertaining to the subject of milling with tungsten- and tantalum-carbide insert milling cutters. In these articles the effect on milling machine design is also discussed. Little need, therefore, be said here on this subject.

Some milling machines were designed, even in advance of the introduction of the new carbide tools, with such rigidity and power that the new tools could be used satisfactorily in them. Others have been basically designed for the new tool materials with suitable speeds, feeds, and power. Faster speeds mean changes in bearing construction and stiffer spindles. Backlash, deflection, and torsional strains must be taken into consideration as never before. Smoothness of operation bears an important relation to the success of the new tools.

It is obvious that the ordinary milling machine of yesterday, however well built and adequate a few years ago, cannot possibly be expected to be speeded up three times as fast as formerly without giving trouble in one way or another. "It is no disgrace," says a well-known engineer in the milling machine field, "to have equipment made obsolete by the introduction of new principles; but it is a disgrace to continue to operate obsolete machines when something that truly meets the new requirements is available."

Fig. 2 shows a machine built by the Consolidated Machine Tool Corporation, Rochester, N. Y., which is especially designed for carbide tools. This is a duplex planetary sliding-head milling machine with four spindles for finishing the ends, starter boss, and fan pads on automobile cylinder blocks. The two planetary spindles in the left-hand head and one planetary spindle in the right-hand head are equipped with carbide cutters. The fourth spindle, in the sliding head at the rear of the machine, is equipped with a high-speed steel cutter, as it has a shorter cut. In designing this machine, it was arranged to feed at a rate of 30 inches per minute, and the three planetary spindles were geared to give a cutting speed of 250, 250, and 350 feet per minute, respectively.

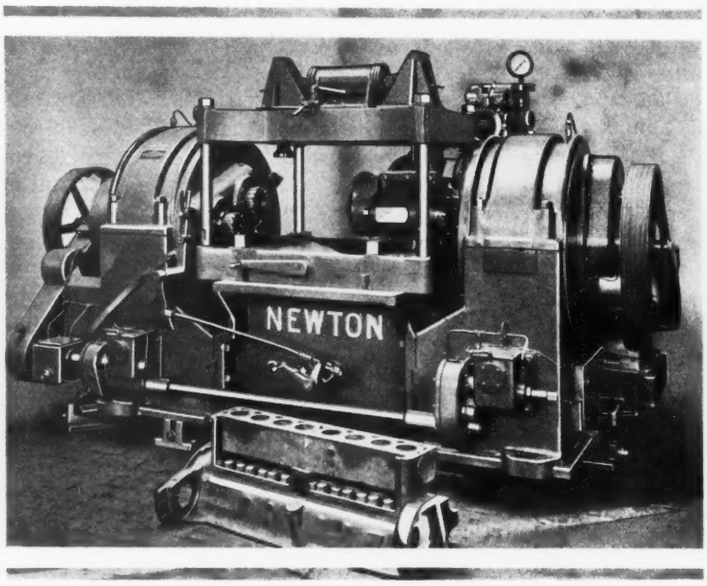


Fig. 2. A Duplex Milling Machine Designed Especially for Tungsten-carbide Insert Cutters

Discussing the effect of the new cutting materials on machine tool design, Leo A. Dumser, chief engineer of the Sundstrand Machine Tool Co., Rockford, Ill., emphasized that one of the effects of cemented carbides on machine tool design would be an increase of 300 per cent or more in cutting speeds. It is probable that the cutting qualities of cemented carbides will encourage the use of much harder product materials and some of these perhaps will be machined at present speeds. The machine tool of the future, therefore, will need a much wider speed range. The higher speeds will require that greater attention be given to the balancing of rotating parts.

Assuming that feed and depth of cut are unchanged, the use of greater speeds necessitates proportionately greater power. This will compel many important changes in the proportions of various machine elements and demand even better workmanship. It will be necessary to increase the

size of anti-friction bearings, because their capacity decreases as speed increases. It may be necessary also to redesign jaw clutches so that they will withstand heavier impacts. Heavier frame sections must be used to support tools more rigidly and to absorb vibration.

Every possible convenience must be provided to enable the operators to run these machines easily and efficiently. Adequate provision must be made for handling large quantities of chips. Cemented-carbide tools seem to operate best at continuous high temperatures. The main function of cutting compounds will be to cool the work piece and the chips to a point where they can be handled rapidly and safely.

Another official of a large machine tool company emphasizes the point that the progress of machine tool design during the last ten years has not only kept pace with the demands and requirements of the machine tool user, but in many instances has been several steps ahead.

With the advent of the new cutting tools, some machine tool manufacturers were faced with the problem of redesigning their line, while others were able, with slight changes, to adapt their machines to the new conditions. Some have gone further and have allowed sufficient margin in their redesigned equipment to outrun the obsolescence factor for several years to come. In other words, they have produced machines that are in advance of the cutting tools.

Summarizing, it appears that the machine tool builders have been fully alive to the requirements. Machine tool users looking for machines to reduce production costs have but to investigate the most modern machine tools built in any type or class, to find that the machines have fully kept pace with the tool materials.

* * *

X-Ray Examination of Steel Castings

By RICHARD K. AKIN, Research Metallurgist
Robert W. Hunt Co., Chicago, Ill.

Some criticism has been made of the use of the illustrations Figs. 1 and 2 in my article "What the X-Ray Tells About Castings" which appeared in April MACHINERY, page 593, on the ground that the castings shown are not typical. These illustrations show the worst defects in several poor castings sent to our laboratories for investigation. It should not be inferred that steel castings with such defects are at all common.

One reason why castings have, in the past, received the brunt of criticisms from the X-ray examination of metals is because foundrymen have been ready to use this method of studying castings with a view to eliminating defects. There has therefore been more information available concerning the X-raying of castings than of other materials.

* * *

A knife blade whetted on a strip of No. 90 emery cloth will cut soft materials such as felt, leather, and soft rubber more effectively than one that is honed to a fine smooth edge.

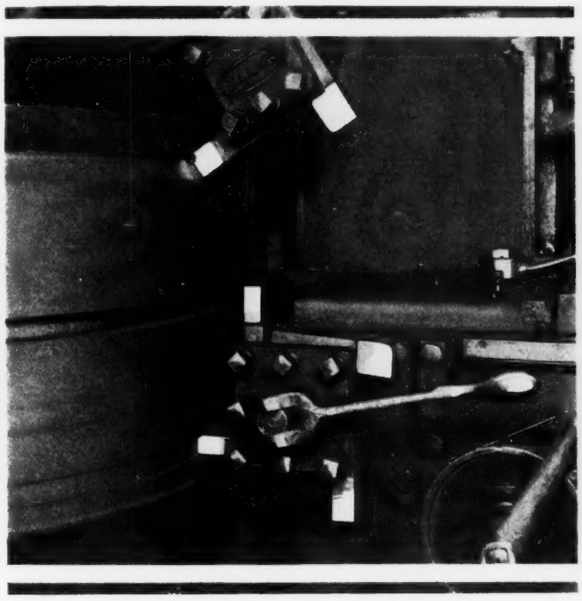


Fig. 3. Grooving a Large Semi-steel Casting with Stellite Tools on a Vertical Turret Lathe

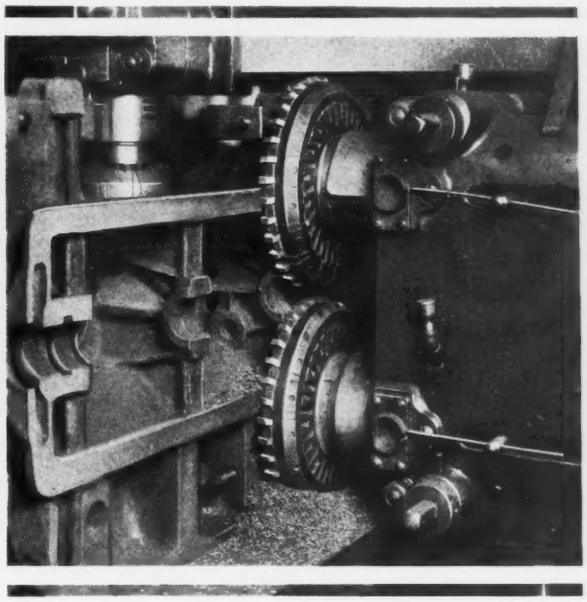


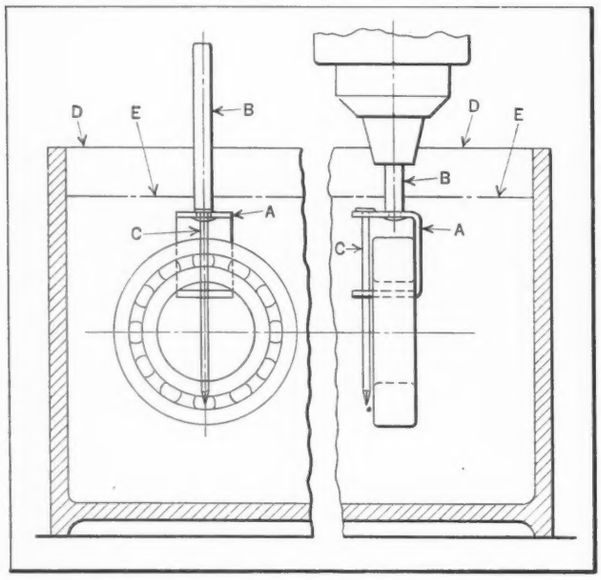
Fig. 4. Milling Top, Side, and Bottom of a Cylinder Block with Stellite Inserted-tooth Cutters

Ideas for the Shop and Drafting-Room

Time- and Labor-Saving Devices and Methods that Have been Found Useful by Men Engaged in Machine Design and Shop Work

Cleaning Ball Bearings Rapidly

Ball bearings for extremely high speeds, which are to be lubricated with a very light grade of oil, must be clean and free from the slushing compound



Equipment for Cleaning Grease from Ball Bearings

in which they are packed. Swishing a ball bearing back and forth through gasoline does not remove all the heavy grease from around the balls where they are in contact with the inner and outer races and from inside the cage. However, an arrangement that does wash these bearings quickly and efficiently is shown in the illustration.

At *A* is a piece of cold-rolled steel, bent to the shape shown and drilled to receive the shank *B*, which is riveted to *A*. Holes drilled through the ends of part *A* admit nail *C*, which prevents the bearing from slipping off. The shank of this assembly is held in the chuck of a drill press and revolved by power for fifteen to thirty seconds in a receptacle *D*, filled up to the level *E*, with clean gasoline.

Waynesboro, Pa. F. A. FIRNHABER

Making Drill-Holders from Old Sleeves

An old taper sleeve, with the outside turned down to a cylindrical form, can often be used to advantage in the turret of a turret lathe or in the jaws of a chuck for holding the smaller sizes of taper-shank drills and reamers.

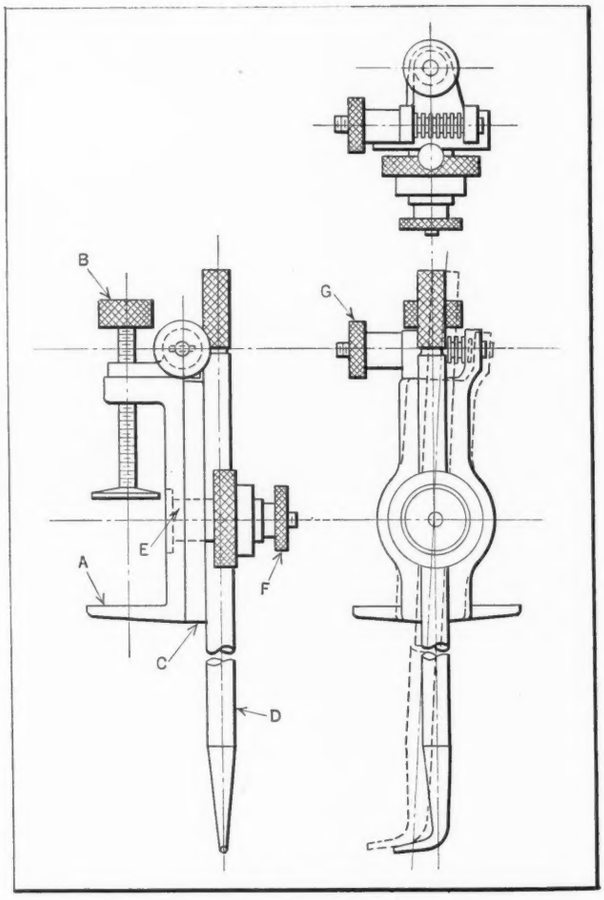
Santa Ana, Calif. CHARLES KAUFMANN

Adjustable Trammel Points

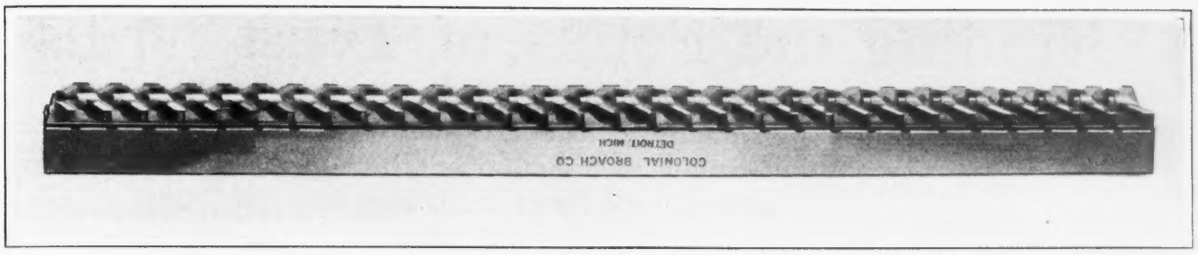
Having a number of fits to make on work of large diameter that was being turned and bored on a vertical boring mill, and not having calipers large enough to make the required measurements, the writer made up an adjustable trammel for the purpose, designed as shown in the illustration.

The body *A* is a bronze casting, which can be clamped to a wooden bar of the required length by means of the screw *B*. The part *C* is also a bronze casting and has a groove in which the trammel point *D* is fitted. This member swivels on stud *E* and can be firmly clamped to body *A* by tightening the nut *F*. A very sensitive adjustment can be had by loosening nut *F* slightly and turning the adjusting nut *G* until the correct setting is obtained. The device can be used for either inside or outside measurements by simply turning the point around to the required position.

Claremont, N. H. F. E. CLARKE



Trammel Point with Sensitive Adjustment



Tungsten-Carbide Broach Produces Over a Million Pieces

Automobile valve guides of the trench type, shown in Fig. 1, are finished all over and then used in pairs with the flat faces *A* and *B* together so as to form complete bushings. These flat faces and the semicircular hole *C* are finished simultaneously with the broach shown in the heading illustration. The parts are iron castings, and about 1/32 inch of stock is removed from the surfaces broached.

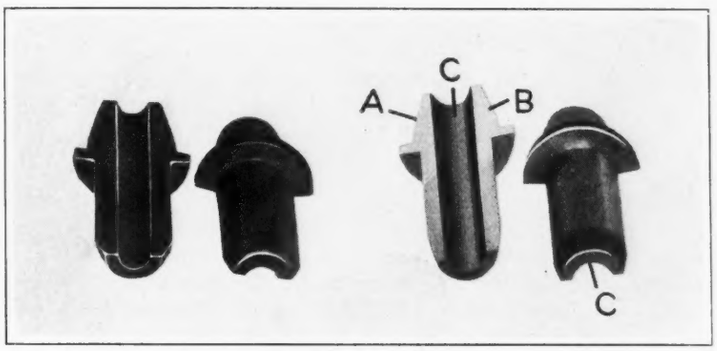


Fig. 1. The Mating Flat Faces and Semicircular Hole of these Cast-iron Valve Guides are Finished Simultaneously with a Tungsten-carbide Broach

The outstanding feature of the broach is that the cutting teeth have tips of tungsten carbide. Production with this tool has reached as high as 1,100,000 pieces, the average life between grinds being from 350,000 to 400,000 pieces. The broach was made by the Colonial Broach Co., Detroit, Mich. When a high-speed steel broach was used on the same operation, the life between grinds was from 35,000 to 40,000 pieces. The operation is performed in a special machine, the broach being held stationary and the work fixtures pulled past it by a conveyor chain.

The broach is made in three sections, assembled side by side. The teeth of the outer sections, which broach the flat faces of the valve guides, slope backward as shown in the upper view at *A*, Fig. 2, while the cutting edges of the middle section, used in broaching the semicircular hole, run straight across, as shown at *B*. The broach sections are 14 inches long, the valve guides being about 1 7/8 inches in length. The hole in the guides is 1/2 inch in diameter. Mild steel was used for the broach body and it was not heat-treated, except for annealing, before cutting the grooves to receive the tungsten-carbide tips. The tips are brazed to the body and have sufficient backing to guard against chatter.

Sulphur oil is used as a lubricant in the broaching operation, soda compound having been found unsatisfactory. The lubricant is forced on the broach and work at a pressure of 75 pounds per square inch so as to wash away the chips.

This application of tungsten carbide is especially interesting, since most mechanical men would not be likely to think of broaching as a field for the new cutting metals.

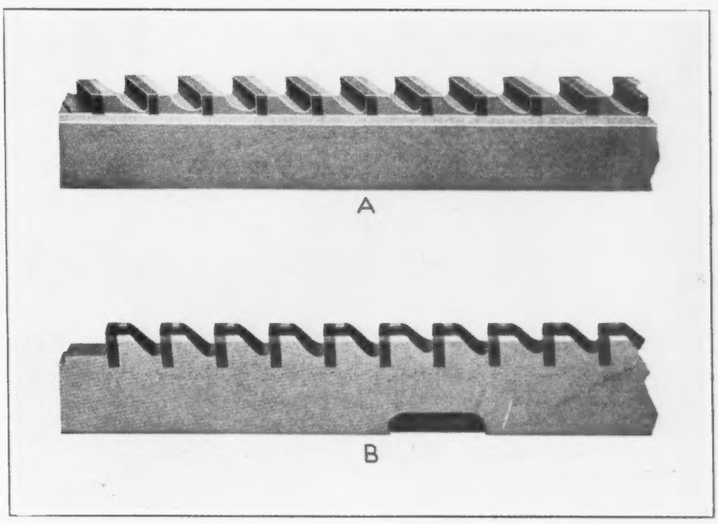


Fig. 2. (A) Side Section of Broach Used in Finishing One Flat Face; (B) Central Broach Section that Machines the Semicircular Hole

Grinding the Points of Twist Drills

Maximum Efficiency is Obtained by Grinding the Points to Suit the Material Drilled and by Using the Correct Feeds and Speeds

By A. J. SNYDER, Physical Laboratory
Morse Twist Drill & Machine Co.
New Bedford, Mass.

TO get the best results from twist drills, it is necessary to have the points ground correctly. The various forms of points shown in Figs. 1 to 10 cover the requirements for drilling the most commonly used materials.

The commercial standard for twist drills is: Included angle of drill point, 118 degrees; lip clearance, 12 to 15 degrees; angle of chisel point, 135 degrees. Drills ground to these angles are suitable for the average classes of work. In the accompanying illustration, Fig. 1 shows the drill point ground in accordance with the commercial standard; Fig. 2 shows the standard lip clearance; and Fig. 3 shows the angle of the chisel point. To have a drill cut properly, the following conditions must exist:

1. Both cutting lips of the drill must be inclined at the same angle with the axis of the drill.

A PROGRESS RECORD IN THE ART OF CUTTING METAL

2. Both cutting lips must be exactly the same length.

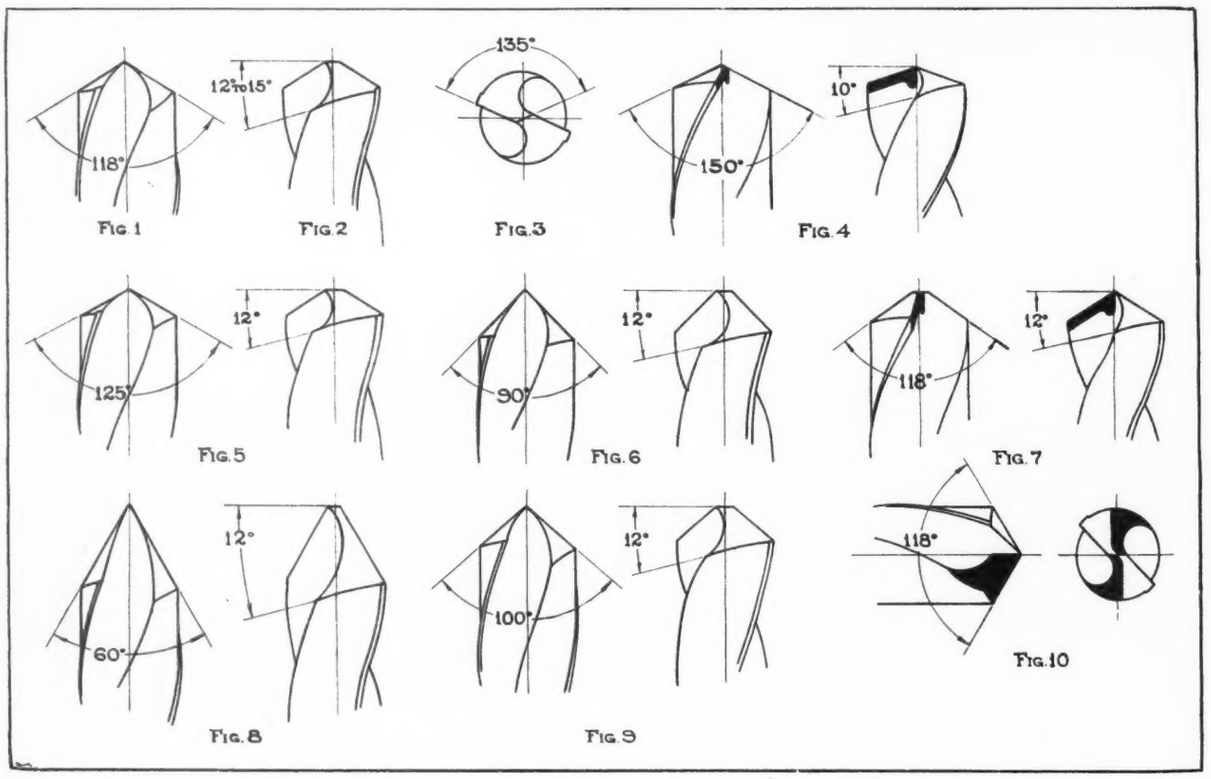
3. The drill point must have the proper lip clearance or contour of the surface back of the cutting edge, and this clearance must be the same on each lip of the drill.

The grinding of the drill point must be modified at times for different grades of material in order to obtain the best results. Hard materials require a blunter point, while soft materials require a more acute angle for the point, as outlined in the following:

4. Drills used in drilling steel rails containing 7 per cent manganese require an included angle of 150 degrees, as in Fig. 4, and a slightly flat face for the cutting lips.

5. Drills for heat-treated steels, such as drop-forgings, including automobile connecting-rods having a Brinell hardness of 250, should have an included angle of 125 degrees, as in Fig. 5.

Figs. 1, 2, and 3. Drill Point, Lip Clearance, and Chisel Point Angles, Respectively, of Standard Commercial Drills. Fig. 4. Drill Point Ground for Drilling Manganese-steel Rails. Fig. 5. Point Ground for Drilling Heat-treated Steel, Such as Drop-forgings. Figs. 6 and 8. Points for Drilling Hard Rubber, Fiber, and Bakelite. Fig. 7. Point for Drilling Brass. Fig. 9. Point for Drilling Copper. Fig. 10. Point for Drilling Crankshafts



6. For drilling soft cast iron, the drill should have the point ground to an included angle of 90 degrees, as in Fig. 6.

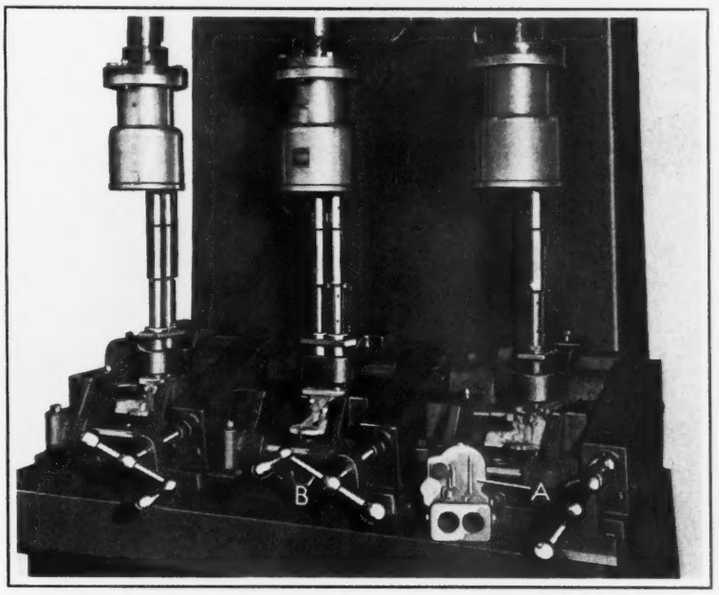
7. For drilling hard rubber, fiber, and Bakelite, the included angle of the drill point should be from 60 to 90 degrees, as indicated in Figs. 6 and 8.

8. Drills for brass should have the point ground to an included angle of 118 degrees, as in Fig. 7, and should have the face of the cutting lip slightly flattened.

9. The proper included angle for the point of a drill for drilling copper is 100 degrees, as in Fig. 9.

10. Fig. 10 shows a drill ground with a chisel point for drilling crankshafts.

Improper grinding of drill points is costly. Efficient results cannot be obtained with a drill unless the grinding is done in such a way that the proper angle of point, lip clearance, and chisel point angle are obtained. The form of the drill point exerts a powerful influence upon the rate of production, accuracy of drilled holes, and the number of holes that can be drilled between successive grindings. Greater efficiency in drilling is made possible by drill grinding machines which provide means for grinding drill points more accurately and much more quickly than can be done by hand.



Tungsten-carbide Bits are Used for Rough-boring Twin Type Carburetors

Causes of Drill Troubles

Imperfect fit of the taper shank of the drill in the socket, due to dirt, chips, and worn-out sockets, often causes breakage of the tang. If the cutting lips are not of uniform length, the hole will be over size and excessive wear will take place on one of the cutting lips. When there is no lip clearance on the drill or a slight negative rake on the lip, the drill will not cut and the heel of the drill will be burned, causing considerable stress to be exerted on the machine.

Too much lip clearance results in an insufficient amount of metal behind the lip, which, in turn, causes the cutting edges to chip and crumble. If the feed is too heavy, the drill point will be crushed and frequently the drill will be broken. Again, if the peripheral speed is too high, the outer corners of the cutting edges will be broken down and the remaining edge of the drill will be quite worn.

Carburetors Bored with Tungsten Carbide

An example of rapid production, obtained by the use of tungsten-carbide tools and three boring units, is shown in the illustration. Here, both holes in the twin type carburetor body *A* are being rough-bored simultaneously. These holes are 3 inches deep and must be machined to within a maximum diameter of 1.420 inches and a minimum diameter of 1.414 inches. About 0.125 inch of stock on the diameter is removed. This job was performed at the plant of the Bendix-Stromberg Carburetor Co., South Bend, Ind.

Through the use of tungsten-carbide cutter bits and three boring units, a production of eighty-eight carburetors per hour is obtained. Two cutter bits are provided on each tool-spindle. The carburetor bodies are gray iron castings.

When the carburetor bodies reach this operation, they have been previously rough disk-ground on one end. For the boring operation, the ground end is seated on locating plugs. One side of the carburetor body fits into a V-block, and the body is firmly gripped when handle *B* is turned to force a clamp against the opposite side of the work. Pilots guide the cutter bits above and below the work to insure straight and parallel bores.

* * *

American Foundrymen's Meeting in Detroit

The American Foundrymen's Association will meet at the Hotel Statler, Detroit, Mich., May 2 to 5. The technical program includes a large number of papers relating to foundry practice and metallurgy. Special sessions will be held on steel founding, non-ferrous founding, gray-iron practice, sand research, patternmaking, apprentice training, and malleable practice. In conjunction with the meeting, divisions of the American Society of Mechanical Engineers will present papers on management, maintenance, and materials handling. These meetings will be held at the Hotel Statler, May 4 and 5. Moving pictures of material-handling installations will be shown under the auspices of the Materials Handling Institute.

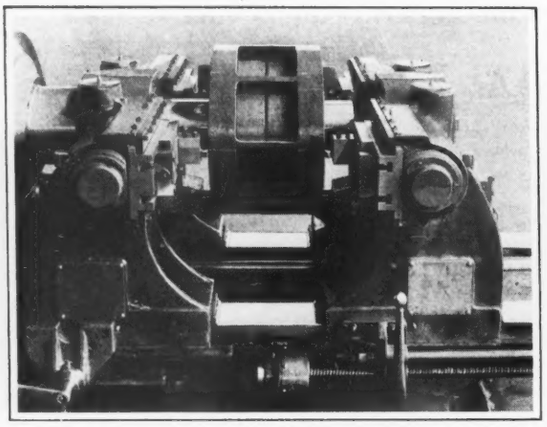


Fig. 1. Machine that Simultaneously Rough-turns, Finish-turns, and Sizes the Rabbet Fit on Both Ends of Motor Frames

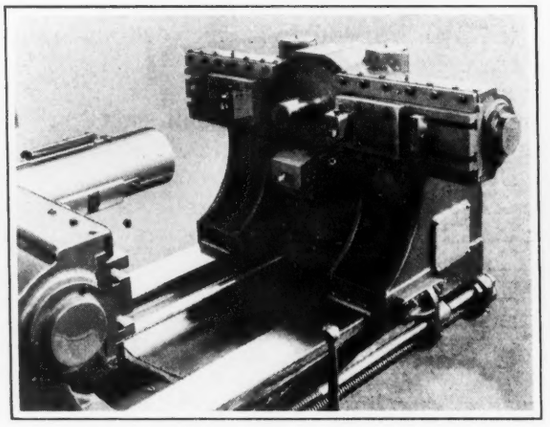


Fig. 2. View of the Air-operated Expanding Mandrel and the Traversing Carriage with its Three Tool-slides

Machining the Rabbet Fit of Motor Frames on Both Ends Simultaneously

The rabbet fit on the ends of electric motor frames must be machined with accuracy because it is from these surfaces that the bearing brackets or end shields are located. The bearing brackets, in turn, align the rotor with the stator. Some manufacturers machine the rabbet fits during the boring operation on the frame and later bore the stator punchings in line by locating the frame from the rabbet fits. Others bore the assembled frame and punchings first, and then machine the rabbet fits with the frame located from the finished bore of the punchings. The Gisholt Machine Co., Madison, Wis., recently designed the machine here illustrated for handling this operation by the latter procedure.

This machine has an adjustable fixed carriage and a second carriage which travels along the flat ways. Each carriage is provided with three tool-slides, together with cams and mechanisms for actuating them. An air-operated expanding mandrel, attached to the spindle of the machine and supported by both carriages, is provided to hold the motor frame for the operation, as shown in Fig. 1. The frame is located in the correct position longitudinally on the mandrel by a stop mounted on top of the fixed carriage. When the air is turned on, the frame is gripped firmly in the bore of the punchings by three wide-faced jaw inserts on the mandrel. The traversing carriage is then moved up to the work by power and a ball-bearing center support or pilot in the housing of this carriage enters the end of the expanding mandrel to provide additional support.

As soon as the work begins to rotate, the front slides on the two carriages start feeding in to rough out surfaces *A*, *B*, *C*, and *D*, Fig. 3. When they reach the end of their feeding movement, the tools are held stationary for five revolutions of the work, after which they are withdrawn 1/32 inch. The finishing tools in the rear slides remain stationary during the first seventeen revolutions of the work, and then start feeding in, reaching the work at the instant that the roughing tools are withdrawn. The finishing slides also carry chamfering tools for cleaning up burrs on the pilot surfaces *A* and *D*.

Sizing tools held in the slides underneath the work are timed to start cutting when the finishing tools are withdrawn. The sizing tools remove very little metal —just enough to clean

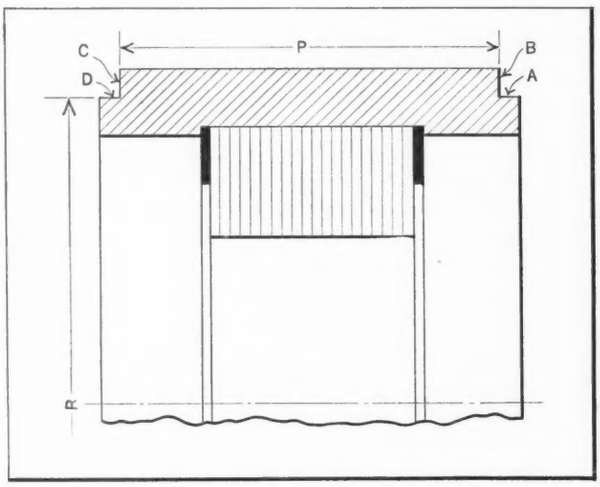


Fig. 3. Diagram which Shows the Surfaces Finished by the Machine Illustrated in Figs. 1 and 2

up surfaces *A* and *D* within the 0.002 inch tolerance allowed on diameter *R*. These tools complete their cut in three revolutions of the work, after which the slides of both carriages return to their starting positions and the traversing carriage returns to the end of the ways. The machine can then be reloaded. The tolerance on length *P* is 0.005 inch.

Cemented tungsten-carbide tools are used for this operation on the eighteen different motor frames for which the machine is tooled. The rabbet fits for these eighteen frames are of three diameters—15, 17, and 19 inches. The machining time for the three sizes is 1.8, 2.2 and 2.7 minutes, respectively, while the floor-to-floor time is 3, 3 1/2, and 4 2/3 minutes.

Besides the eighteen motor frames for which the machine is tooled, a similar series of frames with female rabbet fits can be handled by adding a few tool-blocks and the necessary tools. The machine has a swing of 44 inches.

Machine Tool Builders Decide to Postpone Exposition Until 1933

The annual spring meeting of the National Machine Tool Builders' Association, held at Columbus, Ohio, April 11 and 12, was attended by a very large number of members. The most important action taken was the decision by a large majority to postpone the scheduled machine tool exposition from September, 1932, to September, 1933. Aside from present business conditions, which were regarded as requiring increased emphasis on direct selling efforts, the year 1933 was considered more favorable for other reasons. The decision was influenced particularly by the fact that the "Century of Progress Exposition" at Chicago next year will bring many visitors from abroad who would then arrange to see the great display of machine tools at a machine tool exposition held at that time.

American machine tool builders have often exhibited in European industrial expositions, such as the Leipzig Fair. These exhibits have necessarily been limited in scope. The opportunity of showing the entire range of American machine tools to European visitors in a national exposition is regarded as of unusual value. The total effect of an exhibition of new designs of high-production machines in every line will greatly augment the impressions to be gained from successive single displays. This is especially important at the present time, because recent importation restrictions and higher tariffs have made the sale of American machine tools in Europe more difficult and have created barriers to the profitable use of American machinery by European metal-working factories. The 1933 show will demonstrate convincingly that American machine tools still have a margin of producing capacity sufficient to overcome foreign tariffs or to warrant a reconsideration of these obstructions to trade.

At the same time, the new Cleveland Auditorium, designed with special regard to the requirements of the largest exposition under power so far held, will be ready next year. The new Auditorium will be large enough to house, in a single hall, exhibits which in previous expositions were divided between two buildings. The new structure will be so arranged that visitors will see both machine tools and accessories without moving from one building to another.

During the convention, Dr. C. J. Turk, president, Centre College, Danville, Ky., made an inspiring address on the topic "Which Way America?" A resolution of tribute to the late Carl A. Johnson, past president of the Association, was adopted.

* * *

Speeds and Feeds for Drilling

The Standard Tool Co., Cleveland, Ohio, recommends the following speeds and feeds for carbon and high-speed steel drills:

For carbon steel drills, speeds in feet per minute, operating in mild steel, 60; in tool steel, 30; in cast iron, 70; in brass or bronze, 150; in drop-forgings, 30. The feeds per revolution gradually increase as follows: 0.003 inch for a 1/16-inch drill; 0.006 inch for a 1/4-inch drill; 0.010 inch for a 1/2-inch drill; 0.014 inch for a 1-inch drill; and 0.016 inch for a 2-inch drill.

For high-speed steel drills, the following cutting speeds in feet per minute are recommended: Operating in mild steel, 120; in tool steel, 60; in cast iron, 140; in brass or bronze, 300; and in drop-forgings, 60. The same feeds are recommended for high-speed steel drills as for carbon steel drills.

* * *

Wire Association to Meet in Buffalo Next Fall

The wire industry will have an important share in the 1932 National Metal Congress and Exposition in Buffalo, October 3 to 8. The Wire Association, of which John Mordica, Bethlehem Steel Co., is president, will have a series of meetings during the Congress, and a number of manufacturers of wire and wire drawing equipment have reserved space at the exposition, which will be held in the 174th Regiment Armory. Reservations have already been made for almost one-half the available 50,000 square feet of exhibition space.

Questions and Answers

A Department in which the Readers of MACHINERY are Given an Opportunity to Exchange Information on Questions Pertaining to the Machine Industries

A. B.—Is it feasible to run a chromium-plated shaft in a bearing of some other suitable material, say in a hardened steel bushing, where high speeds with bearing loads not in excess of 50 pounds per square inch (operated without lubrication) would be encountered? If any readers of MACHINERY have had experience with a similar construction, their opinions would prove of value; we would be glad to receive comments for publication.

An Involved Question of Patent Infringement

M. A. J.—"A" applied for a patent which was "allowed" by the Patent Office. A notification was sent by the Patent Office to "A," stating that the patent would be issued upon payment of the final government fee within six months. When the six months' period had almost expired, "A" approached "B" and attempted to sell the patent before it was issued. "B" refused to purchase it, but proceeded to manufacture the device and marketed it without "A's" knowledge or consent. "A" has no correspondence or other proof that such negotiations were carried on with "B." The articles manufactured by "B" had no patent mark, but he sold them in considerable quantities, and apparently had no difficulty in selling them.

The inventor sent the final government fee to the Patent Office, but for some reason the patent was not allowed or became lost. Later the Patent Office issued the patent to "A" as "re-issue."

Is the act of "B" an infringement? Can "A" collect for such infringement from "B?" Also, can "A" collect from the parties to whom "B" sold the devices? What is "A's" best course of procedure to recover damages?

Answered by Leo T. Parker, Attorney at Law
Cincinnati, Ohio

In a suit for the infringement of a patent the three important questions are as follows: Is the patent valid? Do the claims of the patent cover the device or thing in litigation? Has the patentee a legal right to enter suit? If these questions can be answered in the affirmative, an infringer is liable who has appropriated all the important advantages and elements of the invention, whether by the ingenious application of equivalent mechanism or otherwise.

After a complete and thorough investigation, if it appears that "B" is guilty of unlawful and unauthorized use of the patented invention, he is an infringer. If "A" has suffered damages or "B" has realized profit from the sale of the invention, a judgment will be rendered against "B" for this amount. If there is difficulty in arriving at a fair amount, the Court may receive opinions from experts, who may estimate the amount due "A."

Patent infringement suits are under the jurisdiction of the United States Courts. A suit may be filed by "A" against "B" either in the district in which "B" resides or in the district in which the infringing acts are committed, provided "B" has an established business there.

Various Courts have held that an inventor cannot sue and recover damages for infringing acts performed before the patent was issued. In other words, liability for infringement dates from the time the patent is issued, and not from the time the patent is allowed. Therefore, it is my opinion that "A" cannot recover damages or profits from "B" for infringing acts performed before the patent was issued as a "re-issue." In fact, "A" can rely upon only one known case to win his suit.

In this case (Barrett v. Sheaffer, 251 F. 74), it was shown that in August a manufacturer accepted an order for 10,000 articles upon which he secured a payment of $5000. He immediately proceeded to make and deliver several hundred of the articles, knowing that his product was similar to a device on which an inventor had applied for a patent. The patent was issued on November 24. On November 25 the manufacturer delivered 108 articles to the purchaser, in addition to the others that were delivered previous to the issuance of the patent. After the patent was delivered to the patentee, he sued the manufacturer for damages and profits on all the articles made and delivered previous to the issuance of the patent, as well as on the 108 articles delivered November 25.

In view of these facts, the Court, in effect, held all persons involved in making, selling, and using the articles liable as co-infringers for making and delivering the different shipments of articles before and after issuance of the patent. However, it is very doubtful that this decision would be upheld.

* * *

Carbon Steel Tools for Boring

Regular carbon tool steel is still used in many instances for the finish cut in deep-hole boring, especially when boring steel. Carbon tool steel cuts smoothly, and for a light cut holds its size. It is suitable for the last cut preparatory to reaming, as well as for finishing a bore when no further operations are to be performed.

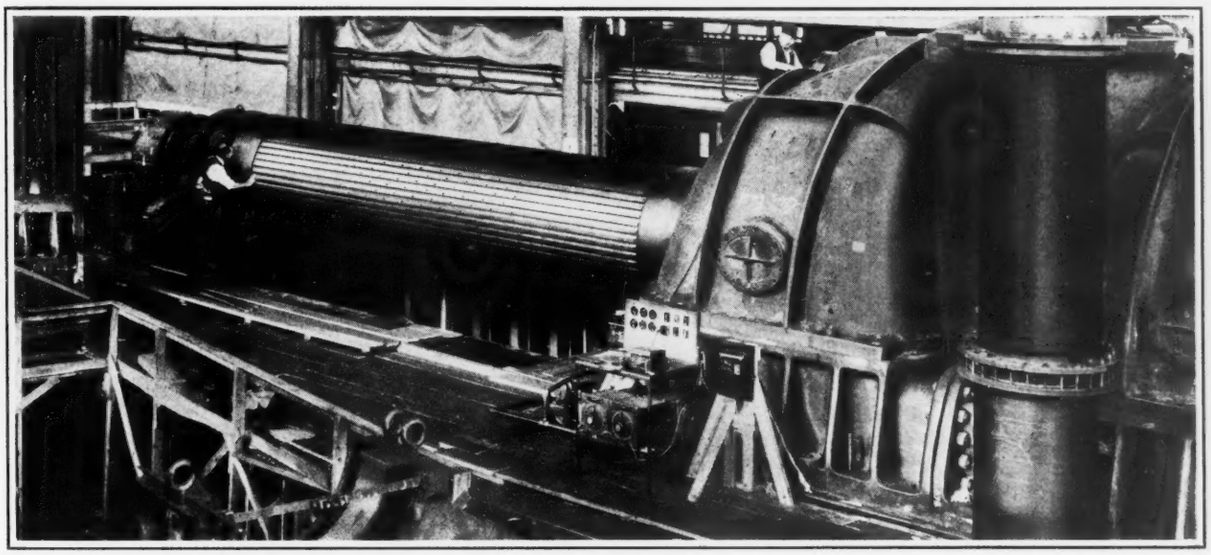
Notes and Comment on Engineering Topics

Photo-electric tubes and thyratrons, besides being used for counting the cars passing through the Holland Tunnel connecting New York City and Jersey City, also control the smoke conditions there. Whenever the smoke gets too thick, this equipment causes the ventilating fans to start up automatically.

In spite of adverse business conditions, air transportation has gone forward considerably since 1929; as the *Journal* of the Society of Automotive Engineers puts it, "Air transport ignored the depression." The number of passengers carried on scheduled air lines in 1930 increased 134 per cent over 1929. Based on the first seven months of 1931, the air transportation during the past year, when complete figures are available, will show a considerable increase over 1930.

A vertical parking machine for use in the Chicago Loop district has been constructed at the East Pittsburgh works of the Westinghouse Electric & Mfg. Co. This is the first public installation of this kind of apparatus, and is a decided step toward the solution of the parking problem in crowded communities. Forty-eight cars can be accommodated at one time in a structure 105 feet high, occupying a ground area of 32 by 24 feet. A 75-horsepower elevator-type motor is employed to operate the parking machine. At East Pittsburgh one of these devices for parking 144 cars has been in operation for more than a year.

In a survey made by the Industrial Machinery Division of the Department of Commerce pertaining to the growing demand for automotive equipment abroad, it is pointed out that there will be a great demand for automotive service facilities as well, making it likely that there will be a market abroad for various types of service equipment. There is a large foreign market for replacement parts for the millions of American-made automobiles that are now in operation abroad. This indicates that service equipment and tools will also be required for reconditioning American cars abroad.



Testing the Revolving Field for a 160,000-kilowatt Turbine-generator at the Schenectady Plant of the General Electric Co.

A huge hydro-electric power plant development is under construction in Switzerland. An artificial lake is being created by building a dam at an altitude of about 7000 feet, near Sion in the Rhone valley. The dam is close to 300 feet high, 1500 feet long, and 230 feet thick at the base. The height of the hydraulic head that will be created is approximately 5300 feet. The output of the power plant will be about 200,000 horsepower.

Metal Trades Association Considers Pressing Problems

AT the thirty-fourth annual convention of the National Metal Trades Association held at the Hotel Commodore, New York, April 20, papers were presented of such an important character that the meeting may be said to have been one of the most successful in the history of the Association.

In his opening address, J. G. Benedict, president for the last two years, briefly reviewed the numerous activities of the Association. He pointed out the gravity of the many problems now confronting industry. The difficulties facing employers are multiplied by mounting governmental expenditures and uncertainties regarding taxation.

Stabilization of Employment and Unemployment Relief Efforts

As far back as 1928, a committee of the Association began an investigation of the possibilities of stabilizing metal trades employment. After a thoroughgoing study, a report was distributed to the membership which made many specific proposals referring to budgeting, cooperation in the collection of trades statistics, a flexible work week, standardization and simplification, methods of employing men at odd jobs when a reduction in productive work becomes necessary, and means of encouraging customer and consumer cooperation. Many of the members have followed these suggestions and have found them to give satisfactory results.

"I think it can be stated without fear of contradiction," said Mr. Benedict, "that employers' efforts to prevent and relieve unemployment are much more extensive than is realized by the general public. By spreading available work, by staggering shifts, by varying hours, by creating additional though unnecessary jobs, employers today are writing economic history far more significant than the semi-hysterical legislation widely advocated by persons unfamiliar with industrial problems."

Trade Education and Apprentice Training Among the Important Activities of the Association

Emphasis was also placed on the work done by the Association in training apprentices and foremen. Serious efforts are being made to keep this work active in spite of the present industrial conditions. Carefully planned trade education is a valuable means of solving many of the problems, not only of industry itself, but of society as a whole.

The same subject was dealt with by Dr. Charles Prosser, director of the Dunwoody Institute, Minneapolis, Minn., in his address "Industrial Education and Changing Trends in Employment." Dr. Prosser called attention to the need for continued study on the part of foremen and supervisors as well as of skilled men. The man who, in these days of industrial advance, thinks that his training is ever completed makes a serious mistake. Keeping abreast of the new developments is one of the important things confronting both industrial firms and the workers in industrial undertakings. Harold S. Falk, chairman of the Committee on Industrial Education, presented a report emphasizing the same ideas concerning the need for increasing efforts in industrial education.

Every address and report presented before the convention dealt with some equally important subject in a forceful and instructive manner. Among these addresses should be mentioned: "Congress and Your Industry," by James A. Emery, counsellor, Washington, D. C.; "Russia Today," by Dr. W. Elmer Ekblaw, Clark University, Worcester, Mass.; "Sino-Japanese Problems," by George E. Sokolsky; "Looking Forward," by Henry D. Sharpe, Brown & Sharpe Mfg. Co., Providence, R. I.; "End Government Waste," by Colonel Robert R. McCormick, publisher, *Chicago Tribune;* "National and International Finances," by Fred I. Kent, New York; and "Unemployment—Cyclical and Technolgical," by Professor Ralph S. Meriam, Harvard University, Cambridge, Mass.

Philip M. Morgan, of Worcester, Mass., presented a comprehensive report on safety and accident prevention, mentioning that in a study made of the causes of accidents in the metal-working field the following were found to be most prevalent: Unguarded grinding wheels, band saws, circular saws, power presses, plate shears, and belts.

Unemployment Benefit Plans are Thoroughly Considered

The Committee on Industrial Relations, of which George E. Randles of the Foote-Burt Co. is chairman, presented a report on unemployment benefit plans which comprehensively reviewed this entire subject, giving a mass of specific data. Further recommendations of this committee will be published at a later date. The committee has a comprehensive plan in mind that will prove to be a great step forward along the lines of securing stabilization of employment in industry and preventing the hardships of unemployment whenever business fluctuations make unemployment unavoidable.

The following new officers were elected: President, Jacob D. Cox, Jr., Cleveland Twist Drill Co., Cleveland, Ohio; first vice-president, Alexander Sellers, William Sellers & Co., Inc., Philadelphia, Pa.; second vice-president, Charles H. Strawbridge, Goodman Mfg. Co., Chicago, Ill.; treasurer, John W. O'Leary, Arthur J. O'Leary & Son Co., Chicago, Ill.

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts, and Material Handling Appliances Recently Placed on the Market

Gleason Spiral-Bevel Gear Generator

Important new features are incorporated in the design of a No. 16 spiral-bevel gear generator brought out by the Gleason Works, 1000 University Ave., Rochester, N. Y., to replace the 15-inch machine that is widely used in automobile and gear-jobbing plants. Some of these features include an improved type of cutter cradle, reversing and indexing mechanisms equipped with hydraulic dampeners that insure quiet and smooth operation at high speeds, a straight-line movement of the work to the cutter, and a liberal use of anti-friction bearings. The improvements promote rigidity and enable the machine to be operated at higher feeds and speeds.

The feeds range from 12 to 73 seconds per tooth, while the speeds, with a 6-inch cutter, range from 64 to 220 feet per minute; with a 9-inch cutter, from 67 to 236 feet per minute; and with a 12-inch cutter, from 73 to 328 feet per minute.

For quantity production, the manufacturer recommends that both gears and pinions be rough-cut on spiral-bevel roughers and that the No. 16 generator be used for the finishing operation only. However, if production requirements are not sufficient to warrant the use of roughers, both gears and pinions can be roughed and finished on the new machine.

The machine consists of three major parts—the frame, work-head, and cutter cradle. The cutter cradle is contained in a circular housing which is bolted directly to the frame, while the work-head is bolted to a carriage that slides at right angles to the root line of the gear being cut. In operation, the work is alternately fed in to the cutter for cutting a tooth space in the blank, and withdrawn, after which the work is indexed for cutting the next tooth space. As the cutter rotates with the blank to produce the lengthwise tooth shape, a rolling movement is produced simultaneously between the cutter and the blank to generate the correct tooth profile.

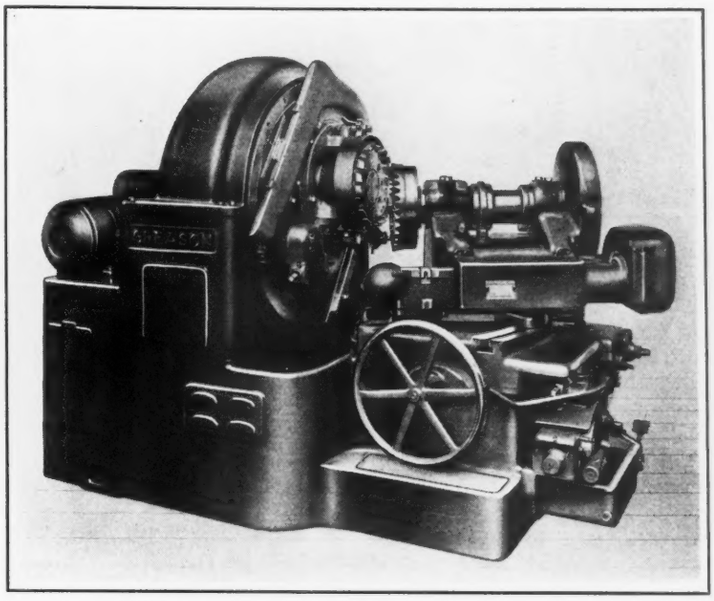


Fig. 1. Gleason No. 16 Spiral-bevel Gear Generator which Replaces the 15-inch Machine

This rolling motion consists of a slow rotation of the cutter cradle in timed relation to a corresponding rotation of the work-spindle, and is analogous to the motion of a gear rolling with a crown gear, the cutter representing a tooth of the crown gear. This succession of movements continues until the last tooth is cut, when the machine stops automatically. The generating motion, number of teeth to be cut, and the feed and speed of the cutter are all controlled by change-gears.

The principal advantage derived from the straight-line movement of the work to the cutter is a materially reduced indexing time, because the movements to and from the cutter can be made more rapidly than before. The large handwheel provides for moving the entire work-head carriage for chucking or removing the work, or for inspecting the first tooth for size and finish.

Adjustments are provided for setting the cutter to suit the spiral angle of the gear to be cut and for taking up cutter wear. In addition, the angular position of the cutter is adjustable in two planes. The latter adjustments provide a means of altering the tooth bearing and make it possible to use one cutter for

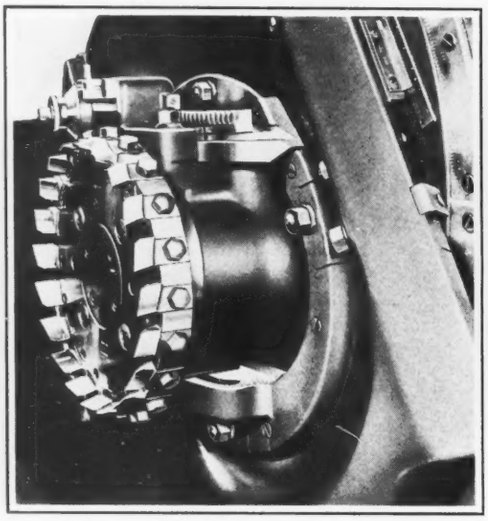


Fig. 2. The Spiral-bevel Cutter and Cutter-spindle Mounting

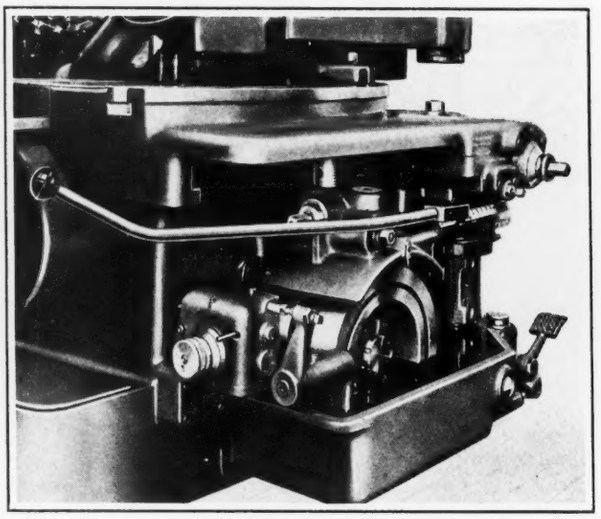


Fig. 3. The Feed-cam, Automatic Stop, and Work-head Clamping Handle

a variety of jobs. A 42-inch 300-tooth dividing wheel controls the generating motion of the cutter cradle.

Gears up to 18 inches pitch diameter can be cut when the ratio is 8 to 1; up to 16 inches, when the ratio is 2 to 1; and up to 12 3/4 inches, when the ratio is 1 to 1. When the gear and pinion shafts are at an angle of 90 degrees, the largest pitch angle that can be cut is 82 degrees 53 minutes, and the smallest pitch angle 7 degrees 7 minutes.

Cleveland Drill Sets

Four drill sets in compact metal cases are being placed on the market by the Cleveland Twist Drill Co., 1242 E. 49th St., Cleveland, Ohio, for the convenience of the user of small drills. The drills in each set fit into a chromium-plated stand, which can be used for holding the drills upright on a bench and can then be easily replaced in the case to keep the drills free from dust, etc., when they are not in use.

Set No. 51 includes all sizes of jobbers' straight-shank carbon steel drills from 1/16 to 1/2 inch, varying by sixty-fourths of an inch. Each drill fits into a properly marked hole in the stand, and the decimal equivalent of the drill diameter is given beside the hole. Set No. 58 is identical with set No. 51, except that the drills are made of Cle-Forge high-speed steel. Set No. 52 includes all straight-shank, carbon steel drills of steel wire-gage sizes from Nos. 1 to 60 inclusive. The drills of the fourth set, No. 59, are identical with those of No. 52, except that they are made of Cle-Forge high-speed steel.

Heald Internal Grinding Machine for Small Work

An internal grinding machine designed especially for handling small work is being placed on the market by the Heald Machine Co., Worcester, Mass. This machine (No. 81) is fully automatic, with the exception of starting, loading, and unloading. It can be arranged to size the work "Size-Matically" or "Gage-Matically," the same as the No. 72 machines. A combination of the two methods of sizing the work can also be provided; and, if desired, the machine can be operated as a plain machine.

While the general functions of the No. 81 grinder are similar to those of the No. 72 line, there is one distinct difference in that the work-head and work reciprocate with the main table instead of having the wheel-head and wheel reciprocate with the table. This arrangement has important advantages for a small machine, besides simplicity and compactness. It permits the entire machine to be driven by a standard single-end motor. It also gives an unusually rigid support for the wheel-head and thus permits the use of the high speeds necessary for small holes. Also, the cross-slide and control box bear a fixed relationship to each other, allowing the use of mechanical controls for sizing and thus eliminating the necessity for electrical connections.

The motor is built in and has built-in electrical controls. The water tank is self-contained and is located within the limits of the base, so that the machine requires a minimum of floor space. An improved hydraulic drive is furnished for the table. Particular attention has been given to guarding completely and enclosing the various units, mechanisms, and belts.

When the work consists mainly of straight open holes and production and accuracy are the main essentials, the manufacturer recommends that the machine be arranged to size "Gage-Matically." This method consists of gaging each piece of work by

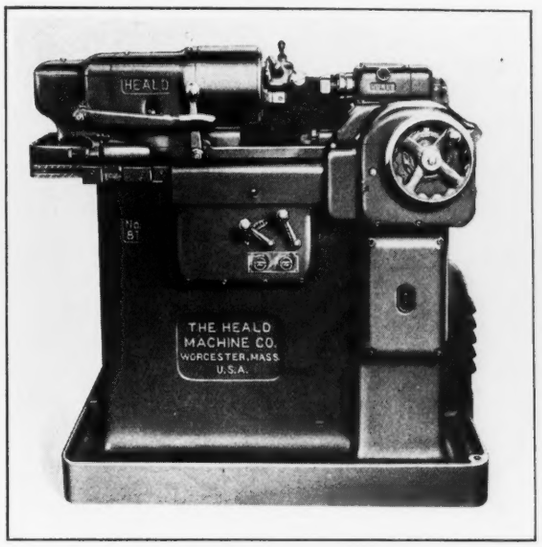


Fig. 1. Heald Internal Grinding Machine Designed for Finishing Holes up to 1 Inch in Diameter and 2 Inches Long

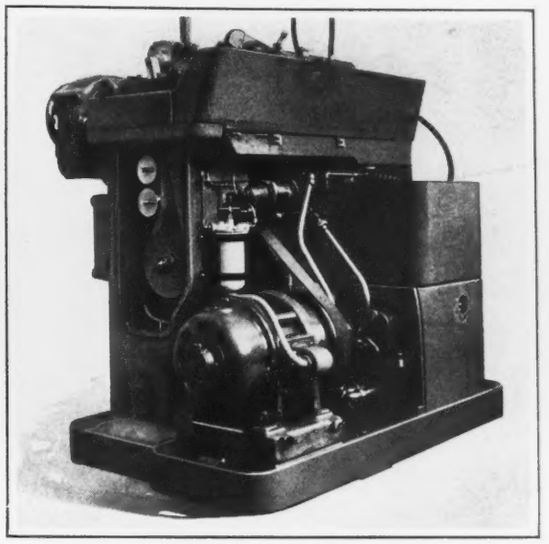


Fig. 2. Rear of Machine with Guards Removed to Show the Motor Drive, Hydraulic-system Pump and Oil Filter

using two solid gages which automatically test the hole for size from the back at each stroke of the wheel. In operation, the work travels at high speed until it approaches the wheel, when it slows down to the roughing speed for the grinding operation.

When the hole has been ground sufficiently to permit the roughing gage to enter it, the work moves away from the wheel, the diamond drops into position, and the wheel is trued at the truing speed. The wheel then starts grinding again, the speed having been changed to the finishing speed and the feed to the finishing feed. When the hole reaches the finished size, the second gage enters it. The work then automatically withdraws from the wheel at high speed and all units return to their rest positions.

When blind, taper, or miscellaneous work is to be handled, the machine is arranged to size "Size-Matically." The sizing is controlled by the cross-slide and the wheel-truing unit. The diamond is set to true the wheel at a definite relationship with the finished size of the hole, after which the grinding is performed with a set number of passes and with a definite advancement of the cross-slide. This insures that the work will be brought to the desired finished size. Therefore, regardless of whether the hole is straight or tapered, with or without interruptions, open or blind, it can be ground with equal ease. The operation cycle is fully automatic as to feeds, speeds, and truing of the wheel.

Some of the important specifications of this machine are as follows: Maximum length of hole that can be ground, 2 inches; maximum recommended diameter of hole, 1 inch; work-head speeds on standard machine, from 900 to 1650 revolutions per minute; and table speeds, from 0 to 40 feet per minute. With standard feed gears, the minimum power cross-feed is 0.00017 inch on the diameter; and with fine feed gears, 0.00007 inch on the diameter. The maximum power cross-feed with standard gears is 0.00102 on the diameter; and with fine feed gears, 0.00042 inch on the diameter.

Kenworthy Dry-Bright Annealing Furnace

A furnace designed for annealing non-ferrous metals by the dry-bright method has been developed by Charles F. Kenworthy, Inc., 195 Piedmont St., Waterbury, Conn. In this furnace, a neutral non-oxidizing atmosphere envelops the charge, which is contained in a covered magazine during the annealing and cooling processes. The principal advantage claimed is the elimination of tarnish on stampings, shells, tubing, etc.

The furnace itself is encased in a steel shell, being closed all around except for a central opening at the bottom. A small hydraulic ram is located in the floor directly beneath this opening. A horizontal rotating platform, which is located eccentrically in relation to the heating unit, has six stations which bring the work-loaded magazines intermittently into line with the opening in the bottom of the furnace. As each of the magazines is swung into position, it is raised into the furnace by the hydraulic ram.

At the end of the annealing period, the magazine is lowered almost to the floor level, swung away from the furnace opening, and allowed to cool. When it has cooled, the inert gas valve is shut off, the cover is taken off, and the annealed parts are removed. Except for short intervals, one of the magazines is in the furnace all the time, while the others are cooling or being reloaded. The furnace is built for electric or gas heating.

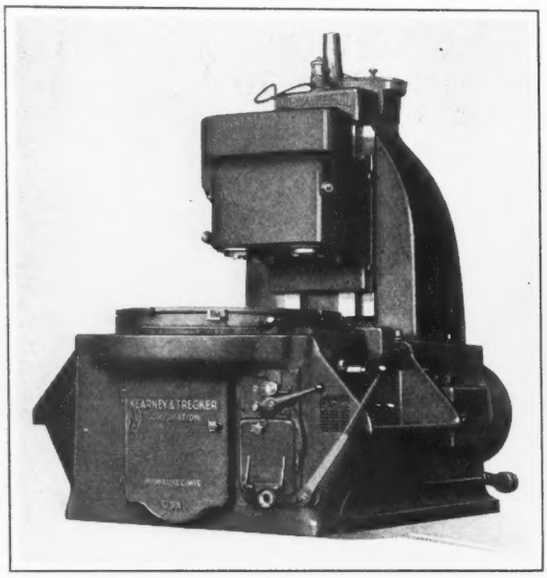


Fig. 1. Mil-waukee-Mil Rotary Type Milling Machine Equipped with a Double-spindle Head

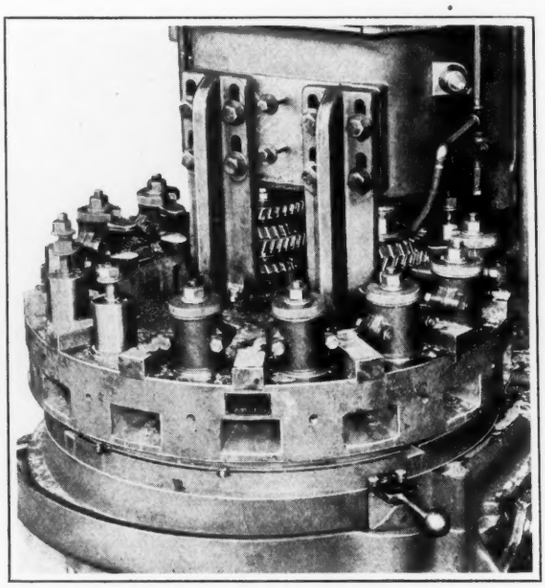


Fig. 2. Close-up View of Machine Set up for Performing a Straddle-milling Operation

"Mil-waukee-Mil" Rotary Type Vertical Milling Machine

A vertical milling machine with a constantly revolving work-table has been developed for high-production work by the Kearney & Trecker Corporation, Milwaukee, Wis. Such operations as face-, side-, and straddle-milling, slotting, form-cutting, and the finishing of radial faces are among the classes of milling that can be handled. High speeds and fast feeds are available for the application of tungsten- and tantalum-carbide cutters, as well as cutters made from other metals.

The table is 36 inches in diameter and is driven by a worm-wheel of approximately the same size, which is mounted on the bottom side. Eighteen table feed changes are available by means of pick-off gears. The feed-change box is located at the front of the machine next to the control levers. A table feed ratio of 40 to 1 is provided, so that the full benefits of tungsten carbide can be obtained even in cases where the cut is light or the material being machined is soft, such as aluminum, for which unusually fast feeds are desirable.

In operation, the table can be fed at the selected rate through the cut and then at the rapid traverse rate of 240 inches per minute to bring the next station to the cutters, after which the normal feed is again engaged. Two levers control the table operation. The one adjacent to the table at the right is for directional control, while the one at the front of the bed is for selecting either the feed or the power rapid traverse. The crank at the end of the bed is for moving the table by hand in either direction when setting up.

Either a single- or a double-spindle head can be furnished, the machine illustrated being equipped with two spindles. One of these is mounted in a quill and has an adjustment to compensate for cutter wear. Special heads may also be supplied with one or more spindles in any position or combination.

Speed changes for the head are made by means of pick-off gears and the box at the top of the upright. Four optional ranges of spindle speeds are available, ranging from 15 to 150, 20 to 200, 30 to 300, or 50 to 500, there being eighteen changes in each range. The spindle control lever is located at the front of the machine on the right-hand side, so that all three control levers are in the normal operating position.

The bed contains two large reservoirs, one for the cutter coolant and one for the lubricating oil, the entire machine being lubricated automatically. Some of the important dimensions of the machine are as follows: Maximum and minimum distance from the face of the spindle to the top of the table, 14 and 4 inches, respectively; maximum and minimum distance from the center line of the table to the center line of the spindle, 16 1/2 and 8 inches, respectively; and cross-adjustment of head, 8 1/2 inches.

In Fig. 2 the machine is shown set up for straddle-milling two bosses of forged-steel spring seats. The cutters on the spindle at the right rough-mill the faces and the others finish them. The fixture holds fourteen work pieces. The operator loads and unloads at the front of the fixture while the pieces at the rear are being milled. In this operation, the production averages sixty-five pieces per hour. Outer supports for the arbors are mounted on the two-spindle head.

Brown & Sharpe "Standard" Vertical-Spindle Milling Machine

A No. 1 motor-driven vertical-spindle milling machine has been added to the "Standard" line of machines built by the Brown & Sharpe Mfg. Co., Providence, R. I. This machine serves as a fast sensitive unit for driving end-mills and shell end-mills in either direction at speeds ranging from 150 to 1800 revolutions per minute. There is a high-speed series which gives correct speeds for mills from 1/8 to 3 inches in diameter, whether they are made of the new cutting alloys or high-speed steel. The back-gear range of speeds gives a smooth drive up to 450 revolutions per minute for large cutters. The machine is intended for both production and tool-room service.

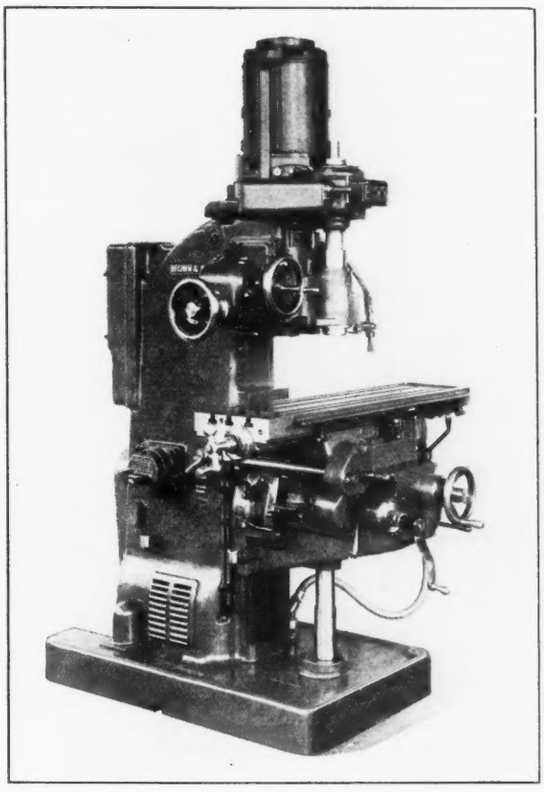
A particular feature is the dual control by means of which the machine can be operated from either the front or rear. An individual motor is used to drive the spindle, there being a second motor that supplies power for the table and spindle feeds. Both motors are controlled from a single push-button station, accessible from the front and rear operating stations. All cutting movements of both the table and spindle are also controllable from either the front or rear. Similarly, feed and speed changes can be made from either position.

There is a power fast travel for the table in all directions, which automatically disengages at the end of the travel. Anti-friction bearings are provided for all main mechanisms, including the spindle drive. An automatic simplified oiling system is another feature of the machine.

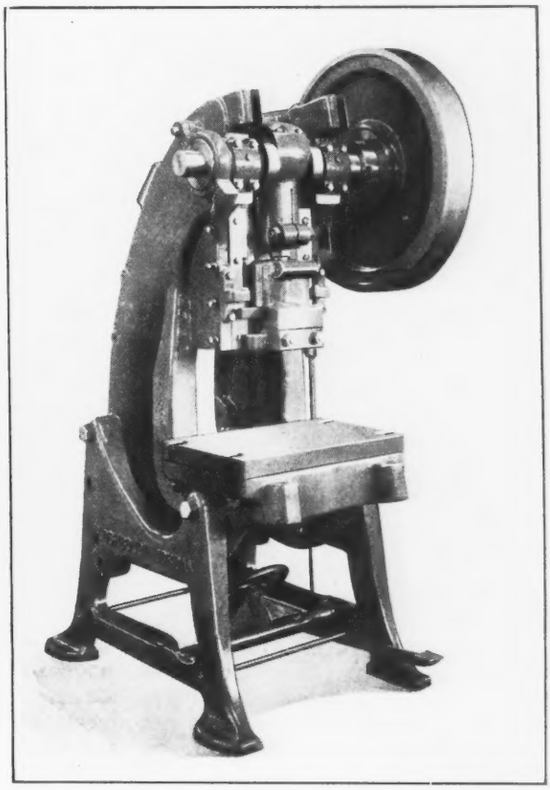
A fast flexible type of speed change is available for the speed motor through a drum-type control and back-gear lever. These are located in a convenient position at the left front of the spindle head. The power feed for the spindle head can be disengaged when not in use. In addition to the power feed, there is an unusually fast hand adjustment of 2 1/10 inches per revolution of the handwheel. Thus the head can be moved the entire length of its travel in less than two turns of the handwheel. The longitudinal hand control is equipped with a new safety handwheel which disengages automatically. There is also a hand-crank.

Loshbough-Jordan Open-Back Inclinable Press

A No. 4 1/2 open-back, inclinable power punch press has been added to the line of the Loshbough-Jordan Tool & Machine Co., Renn St. and Sterling Ave., Elkhart, Ind. This machine will be built in flywheel, geared, and combination-geared types. The flywheel type is capable of applying 40 tons of pressure to the



Brown & Sharpe Vertical-spindle Milling Machine



Loshbough-Jordan Forty-ton Punch Press

ram. The advantages claimed for this machine are large die space, deep throat, larger bolster plate area, large openings in bed and back, and a low bedplate when the machine is inclined.

Fellows Automatic Helical-Cutter Sharpening Machine

A fully automatic machine for sharpening the so-called "normal sharpened" helical gear-shaper cutters has been placed on the market by the Fellows Gear Shaper Co., 78 River St., Springfield, Vt. This machine, a left-hand end view of which is shown in Fig. 1 and a front view in Fig. 2, is provided with a complete electrical control. There are three motors, one for reciprocating the table through a reduction gear and crank mechanism; another for driving the pump that supplies coolant to the grinding wheel and work; and a third for driving the grinding wheel through an endless canvas belt.

Adjustments are provided for sharpening "normal sharpened" helical cutters with either zero or positive top rake. Cutters having helix angles up to and including 50 degrees can be handled, as well as cutters with a pitch diameter up to 5 inches.

Indexing and reciprocation of the cutter are taken care of automatically, and the machine stops upon the completion of each cutter revolution. There are three push-buttons at the front of the machine, as shown in Fig. 2. One of these is for starting the table reciprocation, the second for jogging the table electrically when setting up, and the third for stopping the machine manually. A guard keeps the stop-button depressed when the operator jogs the table.

Rigidity and accuracy are other advantages claimed for this machine. The sharpening operation is conducted rapidly and a smooth finish is obtained on the cutter teeth. All operating levers, push-buttons, etc., are within convenient reach of the operator from the front of the machine. Fig. 1 shows the motor-driven coolant pump, automatic tripping device, etc., the various water guards being removed.

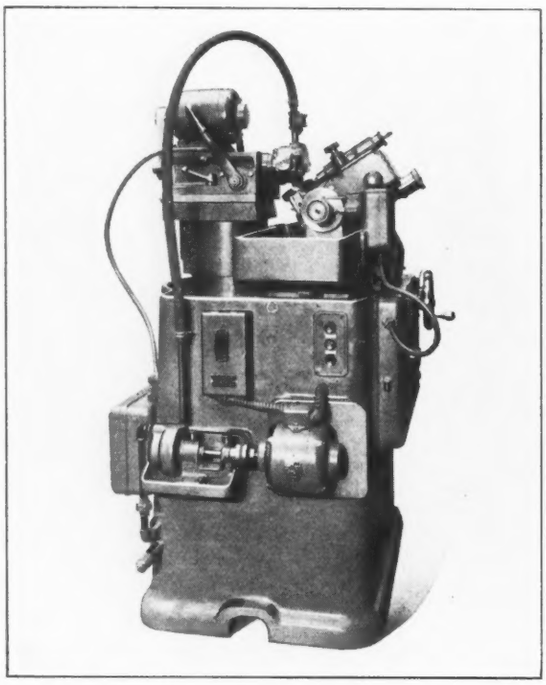


Fig. 1. Fellows Automatic Machine for Sharpening "Normal Sharpened" Helical Gear-shaper Cutters

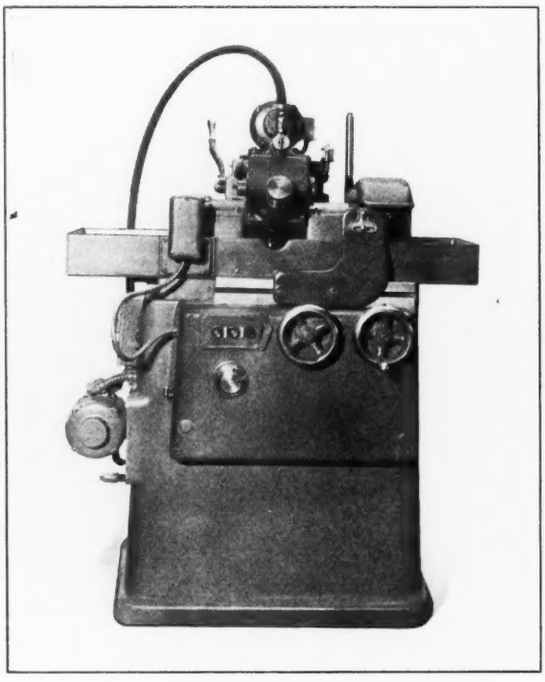
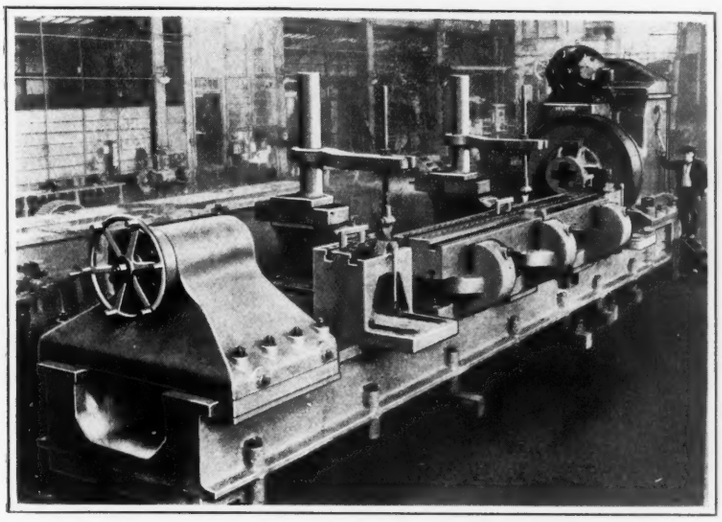


Fig. 2. Front View of the Automatic Sharpening Machine with the Water Guards Removed

Giant Roll Lathe

Rolls up to 82 inches in diameter and 26 feet in length can be accommodated with the standard equipment of a huge roll lathe recently built by the United Engineering & Foundry Co., Farmers Bank Bldg., Pittsburgh, Pa. With slight modifications of the tool equipment, grooved or straight-faced rolls 88 inches in diameter can be swung. The principal demand for rolls of these large sizes is from continuous wide hot-strip mills and four-high plate mills.

The machine is 49 feet long.



Lathe with Capacity for Rolls Approximately Seven Feet in Diameter

It is equipped with roller bearings throughout, and has an enclosed headstock with two speed ranges. Allowance has been made, both in speeds and in strength, for using tungsten-carbide and similar cutting tools. The machine is provided with an automatic lubrication system. It is believed to be the largest roll lathe in the world as concerns capacity, power, and weight, but it occupies no more floor space than a small-sized roll lathe. The bedplate alone weighs over 134,000 pounds.

Landis Four-Inch Rotary Die-Head for Cutting Lead-Screws

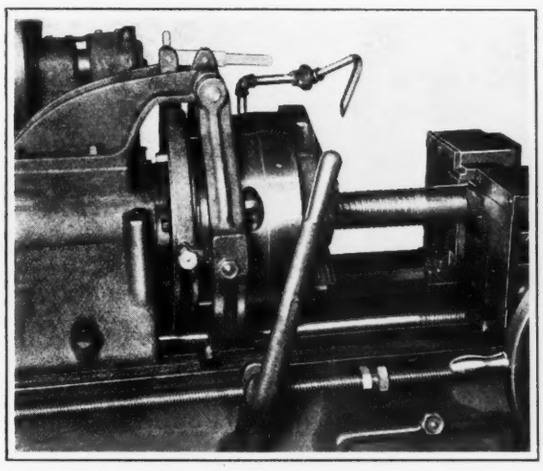
Single, double, triple, and quadruple threads from 3/4 to 4 inches in diameter, with a maximum lead of 1/2 inch, can be cut with a die-head developed by the Landis Machine Co., Inc., Waynesboro, Pa. This die-head is intended for use on the 4-inch lead-screw threading machine built by the company. It is equipped with a roughing and finishing attachment and is designed for cutting coarse-pitch threads on valve stems, vise screws, jack screws, and similar classes of work requiring accuracy and a smooth finish.

The roughing and finishing cuts are controlled by means of a latch mounted on the yoke bracket as illustrated. This latch is released after the roughing cut has been completed, permitting the die-head to close for a light finishing cut. Approximately 0.045 inch of stock is removed during the finishing cut.

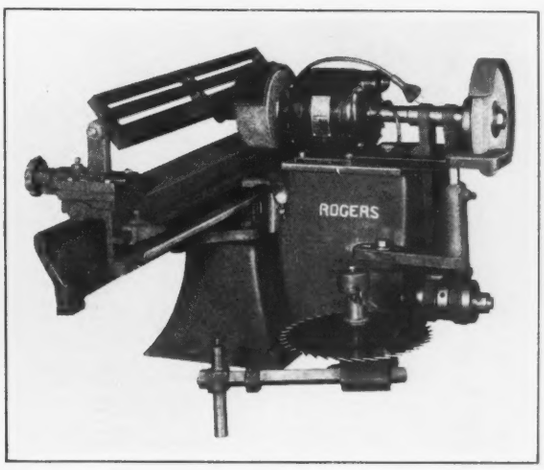
Cutting strains are not transmitted to either the die-head yoke or to the roughing and finishing attachment. The die-head is locked within itself when set for either the roughing or finishing cut, thus making it possible to produce threads that are free from taper and uniformly accurate as to size. A pitch indicator assists the operator in timing the engagement of the lead-screw nut for the finishing cut.

Rogers Electric Utility Bench Grinder

A combination bench grinder equipped with a table for face, surface, knife, or die grinding, a tool-rest for edge-tool grinding, and an attachment for sharpening circular saws up to 22 inches in diameter is being placed on the market by Samuel C. Rogers & Co., 191-205 Dutton Ave., Buf-



Landis Lead-screw Cutting Die-head with Roughing and Finishing Attachment



Rogers Combination Bench Grinder Designed to Handle a Variety of Work

falo, N. Y. On special order, this Model K utility grinder can also be equipped with a 10-inch disk grinding wheel and an adjustable table or with a flexible shaft having an outer bearing for emery or polishing wheels.

The operator can stop the table movement at any time by placing the lever in the neutral position without stopping the grinder entirely. This feature permits close accurate work and gives the operator complete control of the machine.

The feed mechanism is within the base. The reversing mechanism is adjustable to suit the length of knife being ground. Two handwheels at the ends of the slide comprise the cross-feeding mechanism. The circular saw carriage is adjustable to suit any desired hook or tooth shape. The saw-holder is fed by hand to and from the grinding wheel. This grinder is regularly driven by a 1/3-horsepower motor, but a larger motor can be supplied if required.

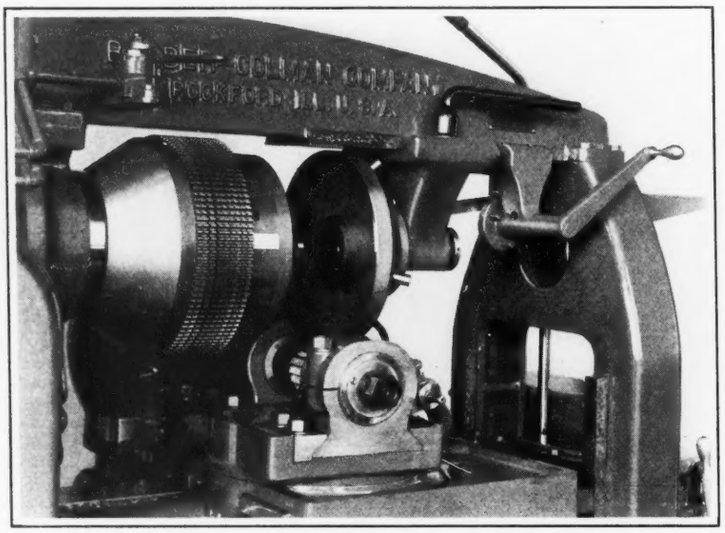


Fig. 2. A Hydraulically Operated Expanding Arbor which Facilitates the Hobbing of Automobile Ring Gears

Barber-Colman Spline-Shaft and Ring-Gear Hobbing Machines

A hobbing machine recently designed by the Barber-Colman Co., Rockford, Ill., especially for cutting long spline shafts is shown in Fig. 1. The new machine consists of the standard Type A machine adapted for cutting spline shafts by lengthening the bed. Other parts of the machine, such as the feed-screw, the automatic stop rods and bars, the power shaft for the feed-box, and the overhanging arm, have been lengthened accordingly. The outer end of the overhanging arm is raised and lowered by a screw driven from the work-spindle elevating mechanism. This insures that the alignment of the arm with the bed ways will be maintained under all conditions.

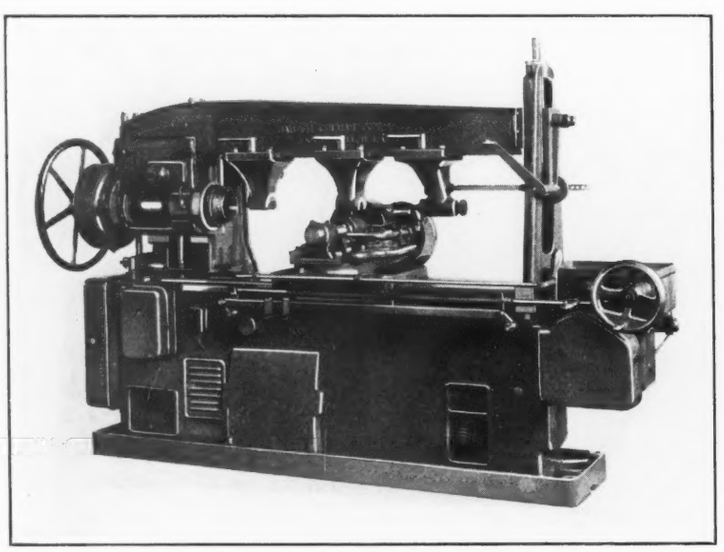


Fig. 1. Barber-Colman Hobbing Machine Designed to Handle Long Spline Shafts

The work-spindle is provided with a collet-type nose and a large handwheel for clamping the work firmly in the collet. Two work-supports are mounted on the overhanging arm. They consist of half-sleeves in which the work revolves and which prevent long shafts from springing out of line during the cut. In other respects, the machine is the same as the Type A machine, described in December, 1931, MACHINERY, page 303.

A close-up view of a Type B hobbing machine equipped with a special hydraulic expanding work-arbor is shown in Fig. 2. This equipment was designed to be used in the production hobbing of starter ring gears for automobile flywheels. With the special work-arbor, the load can be put on and taken off without difficulty, and the blanks are held firmly during the cut, because the arbor is expanded within them and they are also clamped securely from the ends.

The expanding mechanism is operated by oil pressure obtained from a unit at the left-hand end of the machine. This unit comprises an oil reservoir and a

motor-driven pump having an automatic control that maintains a certain pressure in the oil lines. A handle at the front of the machine is operated to shift the control valves as required. Ring gears have been produced in this machine at rates as high as 1 per minute.

Except for the equipment described, the machine is of the standard design described in the November, 1929, number of MACHINERY, page 232.

Cincinnati Quick-Change Collets and Shell End-Mill Arbors

The Cincinnati Milling Machine Co., Cincinnati, Ohio, has brought out a line of quick-change collets and shell end-mill arbors for use with a new quick-change adapter. This adapter is easily mounted on the nose of any milling machine having a 5 1/16-inch diameter standard spindle nose with the National Standard taper hole.

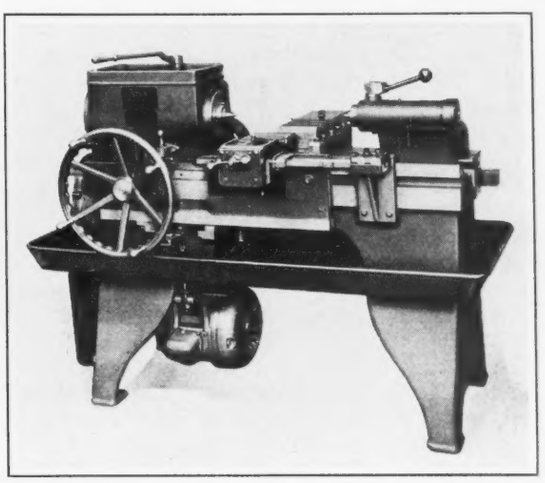
The Large Nut is Given a One-quarter Turn to Lock the Collet or Arbor Securely in Place

The collet (or arbor) is inserted in the adapter, as illustrated, until its taper shank fits snugly into the machine spindle. A one-fourth turn of nut *A* in a clockwise direction then locks the collet securely in place. Only one-third of a minute is required to remove one of the collets and replace it with another. Accurate alignment is maintained because the collet is seated in the spindle taper hole by end pressure produced with the nut.

The new collet, arbors, and adapters will reduce the idle time in tool-rooms and die shops, as they make it possible to perform quickly a variety of operations, such as drilling, boring, and milling, with but one setting of the work. The arbors are available for shell end-mills having National Standard diameters of from 1 1/4 up to 6 inches, while the collets are made with various Brown & Sharpe and Morse taper shanks, and with either plain or tang drives.

Sundstrand Junior Stub Lathe

Speeds and feeds to suit the use of all cutting tools, including cemented-carbide and diamond tools, are available in a Junior Stub lathe being introduced to the trade by the Sundstrand Machine Tool Co., Rockford, Ill. With a 5-horsepower motor running at 1200 revolutions per minute, the spindle speeds range from 128 to 1346 revolutions per minute, and with either a 5- or a 7 1/2-horsepower motor running at 1800 revolutions per minute, the spindle speeds range from 195 to 2050 revolutions per minute. A constant speed of 3600 revolutions per minute is obtained by eliminating pick-off gears and by belting direct from the motor to the spindle. Front carriage feeds from 0.0015 to 0.084 inch per spindle revolution can be provided. The capacity between the centers of this machine is 18 inches; the swing over the bed, 12 inches; and the swing over the front and rear tool-slides, 8 inches.



Sundstrand Junior Stub Lathe with Speeds and Feeds to Suit the Use of All Cutting Tools

Various features provide strength and operating convenience. The headstock and bed are one casting. A cover plate affords ready access to the entire headstock, and also serves as a convenient tool tray. This plate can be removed to permit the application of an extra tool-slide. The master control lever on the top of the headstock operates the spindle, feed clutches, and a spindle brake, though the feeds may be independently controlled by a lever on the front of the headstock. Provision is made for the application of non-rotating air cylinders or other chucking equipment.

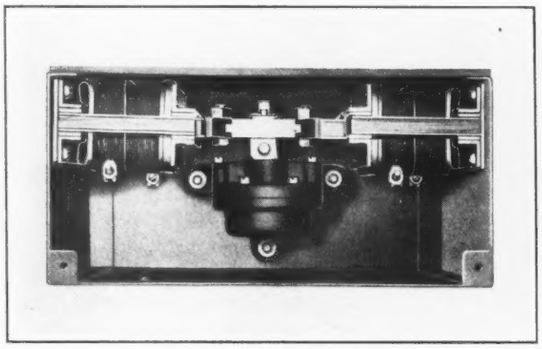


Fig. 1. Electrically Operated Valve for the Four-way Control of Double-acting Air Cylinders

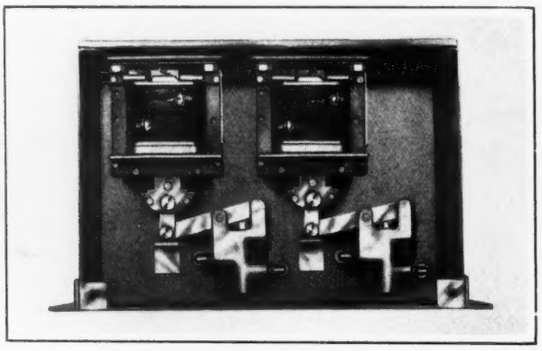


Fig. 2. Valve for the Remote Control of Either Single- or Double-acting Air Cylinders

Automatic control is provided for the spindle and feeds, an adjustable dog automatically starting the spindle and engaging the power feeds as the carriage is traversed. Another adjustable dog automatically disconnects the feeds and the drive to the spindle and also applies the spindle brake. Helical teeth on the feed rack insure a smooth continuous drive. The drum cam which actuates the rear carriage can be easily adapted to give the desired feed movement and dwell. There are independent pick-off gears for the front and rear tool feeds. The large hand-wheel at the front of the machine facilitates rapid movement of the front carriage and rear slide in unison.

A cam bar attachment can be provided at the front of the bed for giving an automatic rapid approach of the front tools to the work for form- or taper-turning. The bracket for this attachment is adjustable to shorten the bar and facilitate settings. An automatic tool relief attachment can also be furnished. The motor is mounted on a leaf which permits adjustment of the multiple V-belt drive. The net weight of this machine, equipped with the rear slide and motor, is 2540 pounds.

Hannifin Electrically Operated Air Valves

Air valves that are operated electrically have been brought out by the Hannifin Mfg. Co., 621-631 S. Kolmar Ave., Chicago, Ill., for application to production machines. The Model E valve, which is shown in Fig. 1, is intended for the majority of industrial requirements. This model is a four-way valve which provides an instantaneous control of air cylinders from one or more push-button stations. It can be used wherever a manually operated valve is now employed.

The Model E valve is of the Hannifin "Packless" disk-type design. It is operated by means of a double push-button switch. Pressing the start button operates the cylinder in one direction, while pressing the stop button reverses the cylinder operation. The cylinder is always under air pressure at one end or the other. This valve may be arranged for cycle operation by means of an automatic time switch. It is furnished for 110- or 220-volt alternating- or direct-current circuits.

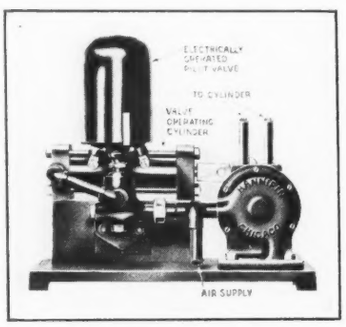


Fig. 3. Valve Unit for Time-cycle Operation or Remote Control

The Model C valve, illustrated in Fig. 2, is made in single and double types for the remote control of either single-acting or double-acting cylinders. It is especially suited to the application of air cylinders for engaging and disengaging clutches on large machinery when it is desired to control the starting and stopping of the machine from a number of stations. This valve can also be operated on 110- or 220-volt alternating or direct current.

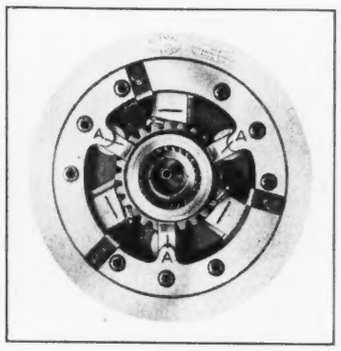
The valve unit shown in Fig. 3, designated Model D, can be operated manually through a push-button station or automatically through an electrical time-cycle unit. This unit consists of an electrically operated pilot valve, a single-acting valve-operating cylinder, and a standard air-control valve. It is designed for operating cylinders of 8-inch bore and larger when the power stroke is to be held for a short period. It can be furnished with a 1/4-, 1/2-, or 3/4-inch operating valve and is intended for use either on alternating or direct current of 110 volts.

De-ion Flashless Circuit Breakers

A group of circuit breakers of a radically new design has been developed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., for use on electrical circuits in homes and industrial plants. These De-ion circuit

breakers take the place of fuses. They have many advantages in that they are safe and flashless, have no parts to be replaced or renewed, and can be reclosed by anyone as easily as a switch. They cannot be kept closed against abnormal overloads or short circuits nor blocked to prevent opening the circuit. A time-lag prevents unnecessary tripping when slight momentary overloads are encountered.

Circuit breakers from 15 to 50 amperes will be available in one-, two- and three-pole combinations for 125- and 250-volt circuits, while 55- to 600-ampere circuit breakers will be available in two- or three-pole combinations up to 575 volts.



Bolender Chuck Developed Especially for Helical Gears

gears in a true vertical plane. Moreover, although the gear is held firmly by fingers *A* so as to prevent any forward or backward motion, it is permitted to move radially in any direction. Thus in the second stage of their automatic operation, the chuck jaws can move in and accurately center the gear so that it can be ground or bored concentrically with the locating points.

As shown in the illustration, the use of pins enables gears to be chucked on the pitch diameter and eliminates the necessity of grinding or locating from the outside diameter. Other means of locating can be used, such as flexible pins, ball cages, or tooth segments.

Lapointe Rotor-Kut Broach

Cored, forged, and pierced holes can be broached from the rough without preliminary drilling, boring, or reaming operations by the use of a Rotor-Kut broach now being brought out by the Lapointe Machine Tool Co., Hudson, Mass. This broach takes both roughing and finishing cuts. An important feature is that the cutting or broaching sections are each polyangular in shape. These sections are preferably arranged in successive groups or series. All the cutting portions in a single series are out of axial alignment with each other. They are equally spaced about the periphery of the broach.

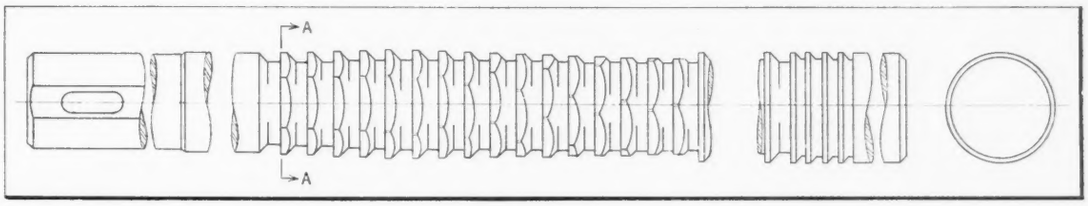


Fig. 1. Lapointe Rotor-Kut Broach Designed for Finishing Cored, Forged, or Pierced Holes from the Rough

Fig. 2 shows a sectional view of a tool designed for broaching cored holes in a cast-iron housing. The roughing section of the broach is 22 1/2 inches long, and it removes about 3/16 inch of stock on the diameter of the hole. The entire length of the broach cutting section, including the finishing end, is 41 1/4 inches, and the total amount of stock removed in one operation is 0.255 inch on the hole diameter. The housing is a long casting, and a hole such as described is broached in a hub at each end, the length of the hubs being approximately 4 inches.

Another broach designed for machining the pierced hole of a

Cimatool-Bolender Helical-Gear Chuck

A grinding and boring chuck that has been developed especially for helical gears, but may also be used for spur gears, is being placed on the market by the City Machine & Tool Works, E. 3rd and June Sts., Dayton, Ohio. When used for helical gears, the chuck is loaded in the conventional manner. Then when the operator releases the draw-bar, instead of the jaws closing immediately, the gear is automatically brought back by three fingers *A*, which swivel 90 degrees into the position shown. After these fingers have swung across the face of the gear, they recede and bring the back of the gear firmly against three buttons which are located in a parallel plane in the chuck body.

In this way, by first grinding or machining the back of the gears, it is possible to automatically locate narrow-faced helical

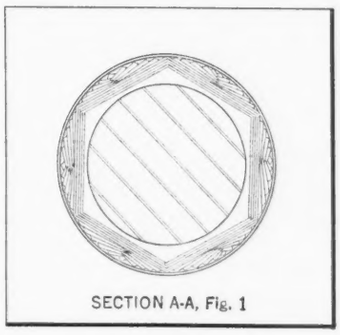
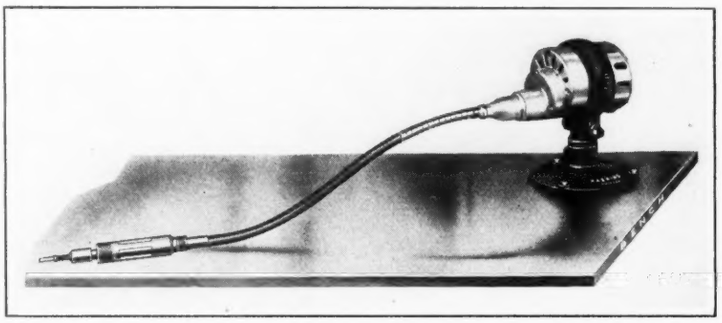


Fig. 2. The Cutting or Broaching Sections of the Rotor-Kut Broach are Polyangular

steel forging has a roughing section 12 inches long, the hole being 2 1/4 inches long and the pierced diameter 1.150 inches. The finished diameter of the hole is 1.318 inches, so that the entire stock removal is 0.168 inch on the diameter. The roughing section of the broach removes 0.115 inch of stock on the diameter.

Long life, increased production, and reduced cost per hole or part are the main advantages claimed for broaches of this type. They can invariably be made shorter than ordinary broaches, and they are designed with a view to removing more stock with less pull. These broaches are especially suitable for removing scale or an excessive amount of stock. Their features can also be incorporated in broaches for cutting splines, internal gears, square, rectangular, or irregular shaped holes.



Haskins Bench Type Screwdriver and Nut-setter with Flexible Shaft

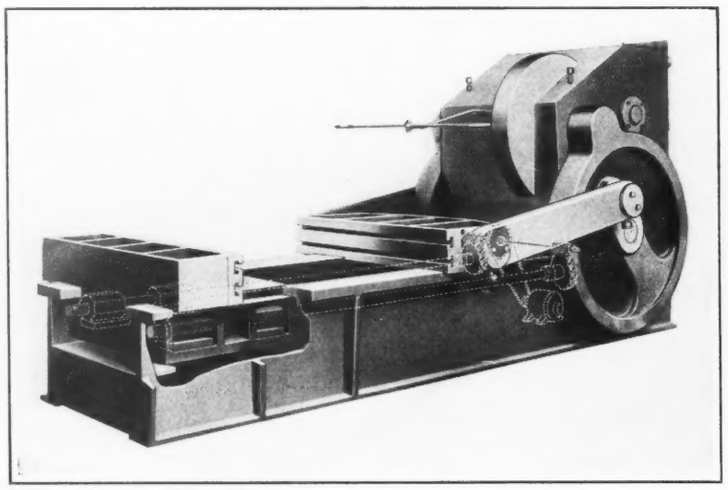
Haskins Flexible-Shaft Screwdriver and Nut-Setter

Screws and nuts often have to be applied under conditions that make the operation a difficult one. To assist in such operations, the R. G. Haskins Co., 4634 W. Fulton St., Chicago, Ill., has brought out the Type BHF screwdriver and nut-setter here shown. This equipment consists of the standard screwdriving unit with a mounting for attaching it to a bench, and a flexible-shaft drive.

The clamp ring which supports the screwdriving unit is free to swivel on the base. This, together with the flexible shaft, gives a freedom of action that permits the operator to apply screws and nuts rapidly. The unit can be located and locked in any convenient position. Obviously, the hand-piece which contains the bit or wrench can be used anywhere on the bench with convenience. The unit embodies the Haskins sensitive tensioning device that insures the driving of screws and setting of nuts to a uniform tightness. This equipment can also be mounted on a movable stand to take it to the work.

Steelweld Bulldozers and Bending Machines

A power-adjusted die-holder is provided on a new line of bulldozers and bending machines developed by the Steelweld Machinery Co., E. 70th St. and Machinery Ave., Cleveland, Ohio. With the exception of this feature, the machines are similar to the one described in March, 1931, MACHINERY, page 559. The power-adjusted die-holder has been provided because the company found that in the great majority of applications, the time required for changing and setting up the dies is a more important cost element than the actual bending of the work. With the new arrangement illustrated the die-holder moves, and so setting-up time and the former search for packing are eliminated.



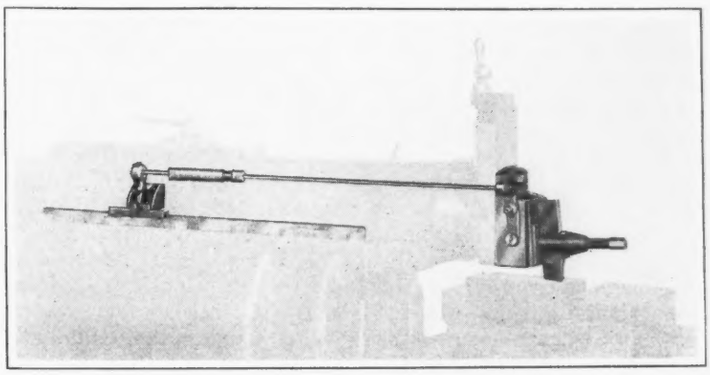
Steelweld Bulldozer with Power-adjusted Die-holder

The bending parts of the dies, which are fastened to the ram and slide, are brought together by merely pressing a push-button. An additional advantage of the new arrangement is that the long tie-rods which run to the operating head of the machine make it impossible to break the tool. The flywheel, clutch, gears, and motor will stall before the danger point is reached.

In a jobbing shop, it is frequently necessary to make heavy bends of a depth requiring more power than can be developed with one stroke on the machine available. With the new machine, it is possible to make such bends on a comparatively light machine by

using two or three strokes and moving the dies up after each one.

This bulldozer has an all-steel frame in which the gearing is enclosed. The main slides are made of hardened and ground steel, the gibs being located underneath the ram where they are free from dirt and scale. The gearing and crank arms are made of rolled steel, there being no castings with the exception of Meehanite gibs. The flywheel and high-speed shaft have anti-friction bearings. Reversing Twin Disc clutches are used.



Device Designed for Automatically Raising Cemented-carbide Shaper Tools on the Return Stroke

Gould & Eberhardt Shaper Tool-Lifter

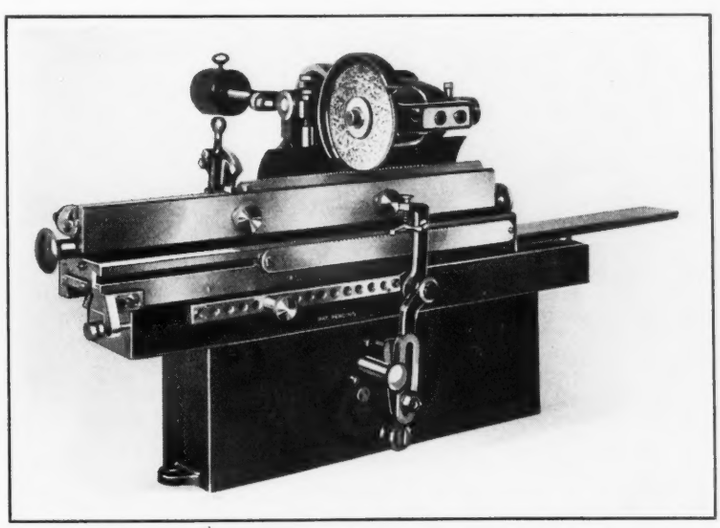
Gould & Eberhardt, Newark (Irvington), N. J., have developed the device here illustrated for lifting the cutting tool of shapers from the work on the return stroke of the ram. This tool-lifter is applicable to the complete line of crank shapers made by the concern, and can be applied to machines now in service. It was developed especially for use with cemented-carbide tools. The device raises the tool clear of the work automatically on the return stroke, and the tool again drops into place for the cut at the beginning of each cutting stroke.

A compensating arrangement takes care of the vertical and angular movements of the tool-slide, and likewise of any angular setting of the tool clapper-box. Thus there is no need for adjustments when the position of the tool is changed.

When not required, the tool-lifter can be disconnected by simply pulling out a plunger in the actuating lever at the side of the clapper-box. Provision is also made to allow the operator to lift the tool, at any time, clear of the work on the return stroke without disconnecting the actuating rod.

Hacksaw Blade Reclaiming Machine

High-speed steel machine saw blades can be reclaimed by sharpening in an automatic machine developed by the L. & L. Mfg. Co., 54-58 Springdale Ave., East Orange, N. J. In addition to the economies effected by saving the blades, various advantages are claimed for the manner in which the teeth are ground. They are ground at a true right angle with the sides, and therefore the operation eliminates any "negative rake" obtained when the teeth are set. In test operations, the reclaimed blades have been found to give remarkable results. Blades can generally be resharpened three times.



"Elenel" Automatic Machine for Reclaiming High-speed Steel Hacksaw Blades

The grinding wheel of this machine is mounted on a frame which swings alternately up and down through the action of a cam. Each successive blade tooth is sharpened as the wheel swings down into contact with the blade, and then, during the return upward movement of the wheel, the blade-holder indexes the distance of one tooth space. This indexing is accomplished through an adjustable cam-actuated mechanism at the front of the machine which includes a pawl that engages a master hacksaw blade. The master blade is mounted on the front of the table, to which the work-holder is attached.

When each operation is completed, the operator lifts the pawl of the indexing mechanism and then pushes the table to the right until the adjustable stop-

screw at the left-hand end strikes a plug which can be inserted in various tapped holes in a bar on the front of the base. The tapped holes provide for positioning this plug to suit different lengths of blades. Each operation is started by pulling out the knob on the front of the machine to engage a feed clutch.

The blade being ground is free to float longitudinally and vertically in a narrow-adjustable slot in the holder. Thus when the grinding wheel comes into contact with the blade, the blade positions itself relative to the wheel, and any inaccuracies in the blade teeth are automatically compensated for. Should a tooth be missing in the blade, the holder will continue to index and the blade will be positioned correctly when the wheel reaches the next tooth. Since the blade is not clamped tight, it does not matter if the blade has been bowed or distorted during the hardening operation or in use.

The blade is supported along the bottom edge by a rest that is held up by a weight until the downward pressure of the grinding wheel overcomes the action of the weight and presses the blade downward. This construction permits a much longer contact between the grinding wheel and each blade tooth than if the blade were held stationary, and therefore blades can be resharpened in a minimum number of passes without burning or annealing the teeth.

The downward movements of the grinding wheel are retarded by a hydraulic device. The resistance of this device can be adjusted in large or small amounts to meet conditions. The up and down movements of the grinding wheel are always the same length, but the position of the stroke must be changed to suit different blade widths. This adjustment can be made instantly.

Several dozen blades can be sharpened with one truing of the wheel. When dressing is necessary, a diamond-holder can be easily applied to the grinding-wheel frame in a definite relation to the wheel. The wheel is dished on one side and ground on the edge to the proper angle.

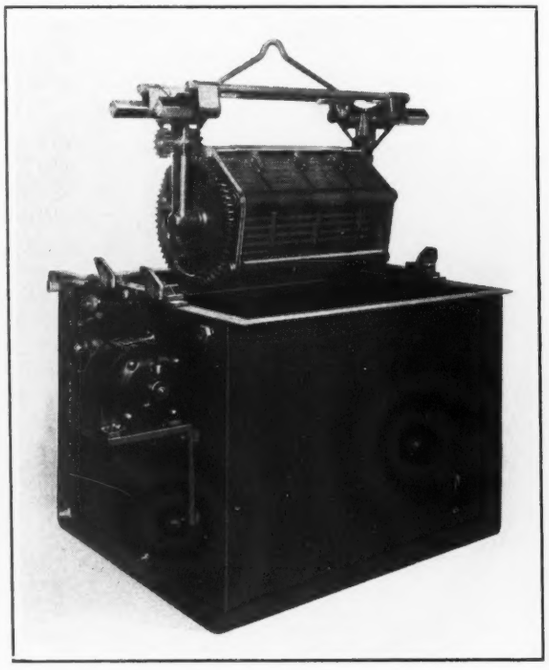
This machine is designed for use on a bench. It is 28 inches long, 15 inches wide, and 17 inches high. It weighs 240 pounds. A repulsion induction motor of 1/16 horsepower is supplied for the drive. Blades up to 21 inches long, from 5/8 to 1 1/2 inches wide, of any thickness, and with any number of teeth per inch can be reclaimed in this machine.

National Barrel-Type Plating Machine

Barrel-type plating machines of both bale and lift-arm styles, manufactured by the National Steel Products Co., Dayton, Ohio, are being placed on the market by the Udylite Process Co., Detroit, Mich. The tanks of these machines are regularly made of double-welded sheet steel. Lined cypress tanks or rubber-lined steel tanks can also be provided. The tanks can be equipped with heating or cooling coils.

The cylinder or barrel is suspended in a hanger, the frame and cathode connecting points being cast integral so that they become the electrical connections when the cylinder is in the operating position. The lower end of the bronze hanger frame serves as the cylinder shaft bearing. It is insulated with molded hard rubber to a point above the solution line. The driving pinions are carried by the hanger and are in constant mesh with the main cylinder drive gear. The drive pinion is automatically engaged with the motor pinion when the cylinder is placed in the operating position.

The cylinder is regularly made of molded hard rubber, this material not being subject to attack by the solutions commonly used in electroplating. However, cylinders made from Formica or Micarta can also be furnished. All parts of the cylinder are interchangeable to facilitate replacement when necessary. The motor and a primary speed reducer are built as a single unit. A belt drive can be installed if specified.



Barrel-type Plating Machine with Barrel made of Molded Rubber

Ransohoff Quenching Tank

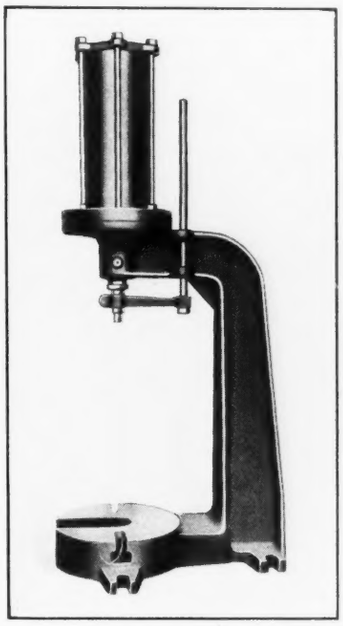
Equipment for quenching heat-treated work in automobile plants has recently been built by N. Ransohoff, Inc., Cincinnati, Ohio. This equipment consists essentially of a large tank with an open-mesh conveyor to which the heat-treated work is delivered automatically from the furnace. The conveyor then carries the work slowly through the quenching tank and discharges it. A propeller wheel, together with baffle plates, keeps

the water in constant circulation in the entire tank. The work immediately comes into contact with the coolest water as it is carried into the tank, resulting in rapid and thorough quenching.

Hannifin Air-Operated Arbor Presses

A new line of air-operated arbor presses, designated as the Series A-1, is being introduced to the trade by the Hannifin Mfg. Co., 621-631 S. Kolmar Ave., Chicago, Ill. These presses are designed with generous throat dimensions, the distance from the center of the ram to the back of the throat being 8 inches. The maximum distance from the table to the ram is 11 inches and any length of stroke up to 10 inches may be obtained.

Five sizes are included in this series, the pressures ranging from 565 to 6280 pounds and the cylinder diameters from 3 to 10 inches. Either hand- or pedal-operated control valves may be furnished. There is a provision to keep the ram from turning. In all sizes of these presses, the frame is a steel casting.



Hannifin Arbor Press Built in Capacities from 565 to 6280 Pounds

Davey Vibrometer

Vertical and horizontal vibrations are measured simultaneously by the Davey Vibrometer, shown in Fig. 1, which has just been placed on the market by the Electrocon Corporation, 6 Varick St., New York City. This instrument is simply laid on the object, the vibrations of which are to be measured. A spot of light traces out the path of the vibration, magnified many times, on a ground-glass scale. Frequency and phase position, in addition to amplitude, can be measured if the instrument is

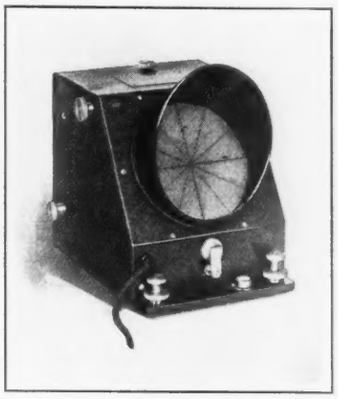


Fig. 1. Vibrometer for Measuring Vertical and Horizontal Vibrations Simultaneously

used in conjunction with the Davey portable balancing equipment described in March, 1929, MACHINERY, page 532.

The Vibrometer works on the principle of the seismograph, the main element being a weight suspended on springs. When the instrument is subjected to vibration above a certain frequency, this weight remains inert in space and is not affected by the vibration in either direction. Light from a small incandescent bulb is reflected on the ground-glass scale in the form of a round spot.

If the vibration is in one direction only, the oscillation of the spot of light will make it appear as a straight line in that direction. Vibrations equal in both directions will produce a circular track of light, and unequal amplitudes in two directions will produce an elliptical light track, as illustrated in Fig. 2. The instrument will indicate accurately the amplitude of vibrations from 400 to approximately 6000 per minute. Comparative readings can also be obtained at frequencies below 400 per minute. The instrument is available in a Model S-2A, which magnifies vibrations approximately 500 times, and in a Model S-2B, which magnifies them approximately 250 times.

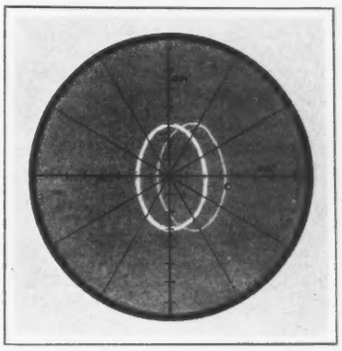


Fig. 2. An Elliptical Light Track Shows Unequal Amplitudes in Two Directions

Photographic records may be obtained of any repeating vibration by sliding a film-holder into a slot immediately behind the ground-glass scale and exposing the film for about five seconds. This instrument is 7 1/2 inches long, 5 1/2 inches wide, and 7 inches high. It weighs 8 pounds.

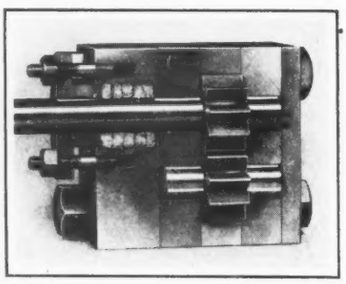
Mercury Switches

The Providence Electric Controls, Inc., 763 Allens Ave., Providence, R. I., has brought out a line of improved mercury switches ranging in capacity from 1 to 100 amperes. These switches can be used for starting, stopping, and reversing motors on various types of machines. They can also be applied to recording and other instruments. In types having a rating up to 5 amperes, special heat-resisting contacts are used. In the larger switches, arcing takes place over a ceramic surface, and thus the danger of tube breakage is eliminated.

Nitralloy Rotary Pumps

A larger series has been added to the line of Nitralloy steel rotary pumps made by the Northern Pump Co., Minneapolis, Minn. These XE pumps have a capacity of from 14 to 42 gallons per minute, running at 1200 revolutions per minute. They are of the same laminated plate construction as the XD series illustrated in November, 1931, MACHINERY, page 230.

When these pumps are to be used for handling lubricating oils, they are equipped with roller bearings, as shown in the illustration of the previous article, but when they are intended for handling crude oils and distillates at high pressures, they are made with Nitralloy plate bearings, as shown in the accompanying illustration. With the roller

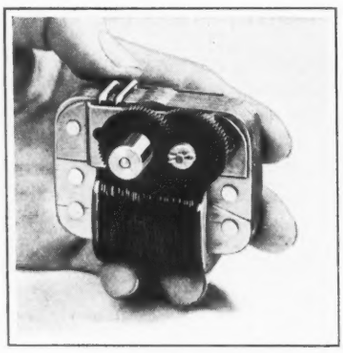


Section of a Rotary Pump Made of Nitralloy Steel

bearings, the pumps are suitable for use on machine tools and hydraulic hoists, cranes, conveyors, and other hydraulically operated mechanisms. With the Nitralloy plate bearings, they are especially suitable for supplying fuel oil to furnaces in industrial plants.

Barcol Small Geared Motor

The small shaded-pole induction motor recently placed on the market by the Barber-Colman Co., Rockford, Ill., and described in December, 1931, MACHINERY, page 313, is now available in the geared model here shown. This model consists of the standard motor and spur reduction gears.



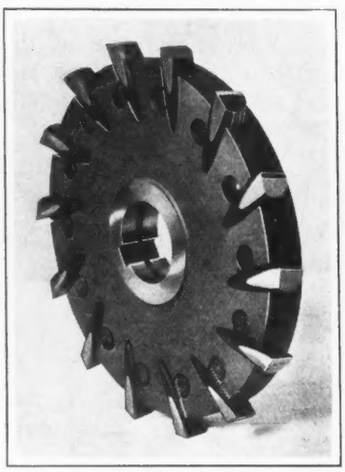
Small Motor with Reduction Gears

The unit will deliver a maximum torque of two pound-inches at approximately 100 revolutions per minute.

The spur-gear speed-reduction mechanism is designed to operate quietly, the two gears being of Textolite and the two pinions of steel. The final drive gear has a fairly large hub that contains an oilless bearing. This gear runs on the motor shaft itself.

Lovejoy Side or Straddle Milling Cutter

The side milling cutter here illustrated was developed by the Lovejoy Tool Co., Inc., Springfield, Vt., for use when side space is limited. It is made either right- or left-hand and embodies the Lovejoy positively locking



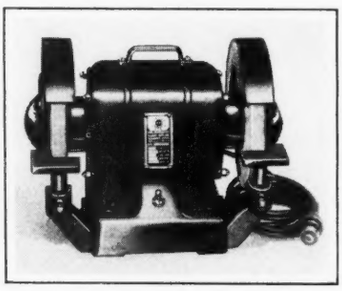
Lovejoy Milling Cutter Intended for Operations where Side Space is Limited

blade mechanism. A blade adjustment of approximately one-half the total length is available to compensate for wear and grinding.

The blades are serrated. Not only can standard or cobalt high-speed steel blades be used, but also Stellite, Stellite J-Metal, or tungsten-carbide tipped blades. The blades are interchangeable in the body or housing, which is made of heat-treated alloy steel. The size of the blades depends to some extent upon the over-all thickness desired.

Premier Ball-Bearing Bench Grinder

The Premier bench grinder made by the Sunlight Electrical Mfg. Co., Warren, Ohio, is now



Premier Bench Grinder with Wisconsin Wheel Guards

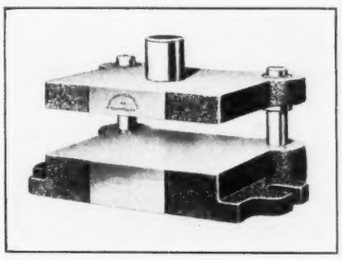
equipped with new flange guards that reduce to a minimum the chances of workmen getting their clothing caught or being injured from the exposed spindle ends.

This bench grinder is made in two sizes, with either a 1/3-horsepower motor running at 1750 revolutions per minute or a 1/2-horsepower motor running at 3600 revolutions per minute. Both motors are equipped with ball bearings, and are of the split-phase alternating-current type. They start with less than 15 amperes, thus meeting the strictest requirements of utility companies throughout the country. The tool-rests are adjustable in all directions. Wheels, 8 by 3/4 inch in size, one coarse and one fine, are supplied.

Danly "Commercial" Die Sets

Standardized die sets and shoes priced to meet the reduced production schedules prevailing throughout industry today are being placed on the market by the Danly Machine Specialties, Inc., 2112 S. 52nd Ave., Chicago, Ill. This low priced "Commercial" line supplements but does not replace the standard "Precision" line.

The sets of the new line are designed to handle requirements of from 300 to 300,000 pieces economically. The only difference between the new die sets and those of the "Precision" line is in the guide posts and bushings. The guide posts are made of a hardened manganese steel and the bushings of a nickel alloy.

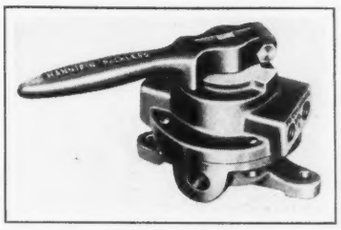


Danly "Commercial" Die Set which Supplements the "Precision" Line

This construction prevents binding and minimizes wear. "Commercial" sets can be converted into "Precision" sets by merely changing the pins and bushings. The new line of die sets is carried in stock at all the plants of the concern.

Hannifin Duplex Air Valve

A "Packless" valve designed for use on machines that employ two air cylinders operating in sequence has been designed by the Hannifin Mfg. Co., 621-631 S. Kolmar Ave., Chicago, Ill. This valve has four independent outlet ports. The two cylinders can be operated in either direction and in any sequence desired.



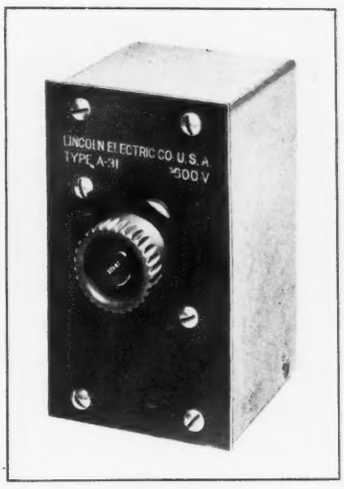
Valve for Controlling Two Double-acting Air Cylinders

This valve is furnished in two sizes with 3/8- and 3/4-inch iron pipe connections, respectively.

Lincoln Improved Push-Button

A number of improvements have been made in the safety push-button introduced to the trade early last year by the Lincoln Electric Co., Cleveland, Ohio. A feature of this switch is that the start button is inside the stop button, as shown in the accompanying illustration.

The stop button can be operated from any angle by striking the front of the control box with the flat of the hand, but the start button must be operated with the finger. The stop button can be locked in the "off" position by pushing it in and twisting it to the right. Heavy springs prevent accidental operation of either button when not locked.

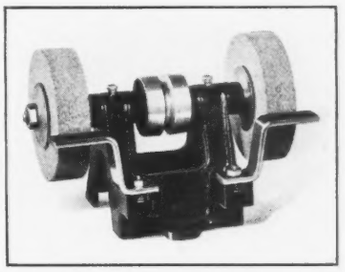


Safety Switch with Hand-operated Stop Button and Finger-operated Start Button

It is claimed that this button switch will handle the heaviest control circuits up to 600 volts, alternating or direct current. The button is self-contained and need not be taken apart or removed from the box cover for wiring. It is known as Type A-31.

Light-Duty Bench Grinder

A light-duty bench grinder intended for sharpening tools or grinding, polishing, and buffing parts has been placed on the market by the Modern Grinder Mfg. Co., 112 S. 2nd St., Milwaukee, Wis., in the design here illustrated. Two 4- or 5-inch vitrified grinding wheels or polishing, buffing, or wire-brush



Light-duty Grinder Made by the Modern Grinder Mfg. Co.

wheels can be supplied. The pulley is designed to accommodate either a flat or a vee belt.

The machine is intended for use in shops, garages, schools, or homes. It has an over-all height of 5 1/2 inches. The distance between the wheels is 5 1/2 inches, and the length of the spindle 9 inches.

Rhoads Tannate Special Rounded Belt

Longer life, less stretch, and greater firmness are advantages claimed for Tannate special rounded belt, now being placed on the market by J. E. Rhoads & Sons, 35 N. 6th St., Philadelphia, Pa., in comparison with the regular Tannate belt made by the concern. These advantages are

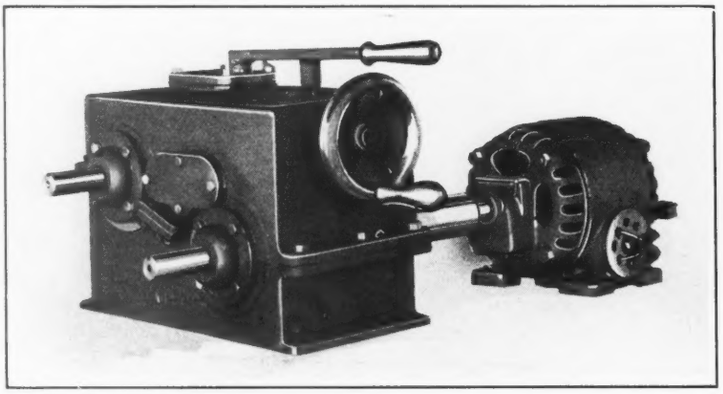
the result of a special tanning process recently developed. It is mentioned that twenty-five different materials are used in the production of this rounded belt. The belt can be conveniently unwound from the spool on which it is wrapped without removing the spool from the container in which it is shipped.

Combined Variable-Speed Transmission and Reduction Unit

A combined variable-speed transmission and reduction unit recently developed by the Lenney Machine & Mfg. Co., Warren, Ohio, is shown in the illustration. An infinite number of speeds between 15 and 150 revolutions per minute are regularly obtainable by means of this equipment, with the motor running at a constant speed of 1750 revolutions per minute. Other speeds can also be furnished.

The speeds are controlled by a handwheel on the box, and they can be changed instantly while the transmission is in motion. Forward or reverse rotation can be obtained by merely operating a lever, and the same lever is manipulated to place the equipment in neutral.

The operation of this transmission and reduction unit is accomplished without gears, screws, worms, or belts. The motor is coupled direct. The equipment is applicable to machine tools, conveyors, etc.



Transmission Unit which Gives an Infinite Number of Speeds between the Minimum and Maximum, Either in Forward or Reverse Direction

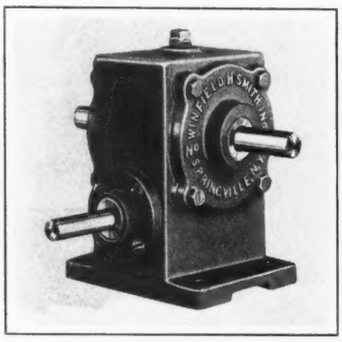


Fig. 1. Smith Speed Reducer for Loads up to 1/4 Horsepower

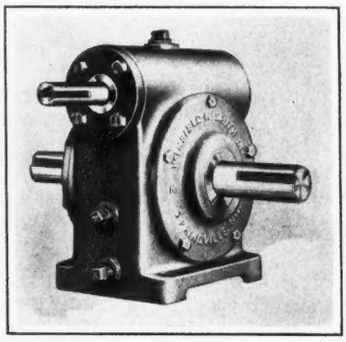


Fig. 2. Speed Reducer for Loads from 1/4 to 1 1/2 Horsepower

Smith Small-Sized Speed Reducers

Two new series of worm-gear speed reducers have recently been added to the line of Winfield H. Smith, Inc., 416 Eaton St., Springville, Erie County, N. Y. The No. 3 1/2 B shown in Fig. 1 is designed to transmit loads up to 1/4 horsepower. The housing is made with a solid top and large side cover plate. This construction permits the worm-gear to be keyed to the shaft and other assembling to be done before the shaft is put into the housing.

The worm-gear is mounted on Timken roller bearings and the worm-shaft in Gurney Radiothrust ball bearings. All shaft extensions are protected by special oil seals. The standard ratios for this unit are 58 to 1, 36 to 1, 18 to 1, and 9 to 1, but special ratios can be supplied.

The No. 4 1/2 T reducer shown in Fig. 2 is capable of transmitting loads from 1/4 to 1 1/2 horsepower. Standard ratios range from 6 to 1 up to 60 to 1. In these reducers the worm is located above the gear. As in the other design, the worm-shaft is mounted in ball bearings and the worm-wheel is mounted on roller bearings.

* * *

Standardizing Lathe Tool Nomenclature

Serious confusion in the names applied to lathe tools, even among those who are most closely in contact with lathe operation, has been revealed in a survey conducted by the American Standards Association. It was found, for example, that qualified mechanical men did not agree even as to what was a left-hand tool and a right-hand tool. What one man called a "right-hand straight turning tool" was designated by another as a "left-hand straight roughing tool." Another tool was called a "left-hand side-boring tool" by one, and a "right-hand hook tool" by another. Because of this, a subcommittee has been organized by the American Standards Association that will attempt to prepare a nationally acceptable nomenclature for lathe and other tools.

* * *

A flat-head wood screw, of suitable size, used in place of the usual wedge for tightening a handle in the eye of a hammer, will be found superior to any form of wedge.

Men in the Industry

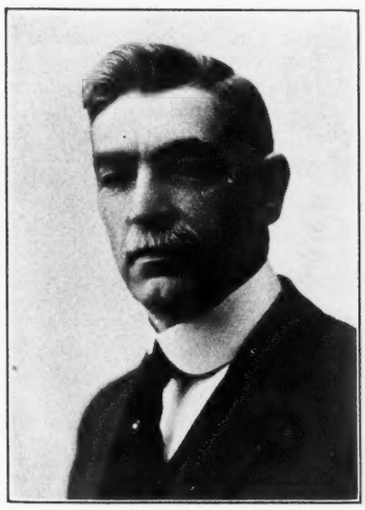
FRANK R. WHEELER has been appointed special sales representative for the Worthington Pump & Machinery Corporation, Harrison, N. J. Mr. Wheeler will make his headquarters at the Chicago office, and will cover the Midwest territory.

CHARLES V. FISH has been appointed representative of the Reliance Electric & Engineering Co., Cleveland, Ohio, manufacturer of alternating- and direct-current motors, in Allentown and northeastern Pennsylvania. His headquarters will be at 515 N. Lafayette St., Allentown, Pa.

WILLIAM S. WILBRAHAM, who has been in charge of the estimating and order department of Lukenweld, Inc., Coatesville, Pa., since that organization was established in 1929 to manufacture welded parts for machinery and equipment, has been appointed assistant manager of sales.

CHARLES L. WASMER was elected president of the Wasmer Bolt & Nut Co., 13,000 Athens Ave., Cleveland, Ohio, at a recent meeting of the board of directors. Mr. Wasmer will also be in charge of sales. He was formerly chairman of the board of directors of the United Screw & Bolt Corporation of Cleveland and Chicago.

NICODEMUS BOSCH, president of the Western Machine Tool Works, Holland, Mich., was elected Mayor of that city by a large majority at the election held on April 4. This will be Mr. Bosch's fifth term as head of the municipal government of Holland; he has previously served in 1912, 1913, 1914, and 1918. In the present election he received the largest vote ever accorded a candidate for Mayor of Holland, having been drafted into the campaign by those who believed that his election would insure economy in municipal affairs.



Nicodemus Bosch

GEORGE PAULL TORRENCE, vice-president in charge of the Indianapolis operations of the Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., was elected president of the company at the last annual meeting of the stockholders. Mr. Torrence is a graduate of Purdue University, class of 1908, and has had twenty-one years' experience in various departments of the company that he now heads.

George Paull Torrence

HARRY J. HOSKING has left his position with the research laboratory of Roessler & Hasslacher Chemical Co., Niagara Falls, N. Y., to take up similar work with Foster D. Snell, Inc., 130 Clinton St., Brooklyn, N. Y. W. C. PINKERTON, formerly with the International Exposition Co., is now industrial representative with Foster D. Snell, Inc.

H. C. DARBY has been appointed district sales manager for the Inland Steel Co. of Chicago, Ill., at the company's Kansas City, Mo., office. Mr. Darby has been a member of the sales force of this office since November, 1926. He succeeds the late Orville P. Blake, previous manager of the office. Announcement is also made that MARK HILL has been appointed salesman in the Kansas City office.

E. P. BLANCHARD, who has been connected with the Bullard Co., Bridgeport, Conn., for the last twelve years, having served as advertising manager and sales manager, was elected a member of the board of directors at the annual meeting of the company.

E. P. Blanchard

A. R. PETERSON has been appointed to the staff of the Chicago district sales office of the Westinghouse Electric Elevator Co., Chicago, Ill. In 1928, Mr. Peterson, who is a graduate in mechanical engineering of the Lewis Institute of Chicago, was president of the Chicago Elevator Manufacturers' Association. For the last twenty-one years, he has been associated with the Elevator Supplies Co., Inc., Hoboken, N. J., of which he has been Chicago district manager for the last twelve years.

Obituary

WILLIAM NEWTON AGNEW, traffic manager since 1910 of the Worthington Pump & Machinery Corporation, Harrison, N. J., and assistant to the president for the last three years, died suddenly on April 12 at his home at the Hotel Woodward in New York City. Mr. Agnew was born in Seymour, Ind., April 26, 1876, and received his education in the schools of Cincinnati, Ohio. His first position was with the Procter & Gamble Co. in Cincinnati, following which he went to Louisville, Ky., in 1895, as freight agent for the Baltimore & Ohio Railroad. Sensing the possibilities of the industrial side of railroading, then in its infancy, Mr. Agnew joined the Durant Dort Carriage Co., of Flint, Mich., as traffic manager in 1901. In 1910 he became traffic manager of the International Steam Pump Co. and succeeded to the same position upon the organization of the Worthington Pump & Machinery Corporation in 1916.

Most Complete Technical Dictionary Ever Published

HOYER-KREUTER TECHNICAL DICTIONARY. Sixth Edition. Three volumes; three languages; 2295 pages (total), 7 3/4 by 11 inches. Published in Germany; sole agent in the United States, THE INDUSTRIAL PRESS, 148 Lafayette St., New York City. Price, for the three volumes, $55; for two volumes, $37.50; for one volume, $19.50.

After years of work, the Hoyer-Kreuter Technical Dictionary has been published in a new and greatly enlarged edition (the sixth edition) including 100,000 carefully selected technical terms embracing various industries, arts, and sciences. This colossal work is in three large volumes: German-English-French; English-German-French; and French-German-English. Volume 1 has the German words alphabetically arranged, with definitions following in both English and French; Volume 2 has English entry words, with definitions in German and French; and Volume 3, French entry words. The technical elements of the three languages thus become interchangeable.

The five editions previously issued are being used in all parts of the world. These earlier editions, however, are specialized dictionaries limited to distinct fields, whereas the new Hoyer-Kreuter Dictionary is universal in scope and includes a vast number of terms not given in previous editions but required in an all-around translator's guide. About 44,000 terms have been added to the sixth edition to cover the newest developments in the world of science and industry. A great many of these terms are essential to translators, because, while special in character, they have been thoroughly standardized by common usage in some industry.

This three-language dictionary, covering the world of science, industry and commerce, has, broadly speaking, a two-fold use—it is indispensable in connection with technical reading and research, embracing the valuable literature of Germany and France; and it is of assistance to everyone engaged in international trade, both in translating foreign communications accurately and in writing letters.

This new dictionary will be found especially valuable by industrial works of all kinds interested in foreign developments or trade; export and import houses; research workers in laboratories and schools; agencies having foreign accounts or offices; libraries; officials and trade representatives; consular and customs' offices; and every individual or business enterprise connected in any way with foreign developments or trade.

The well-known technical engineer, Dr. Alfred Schlomann (also author of the Illustrated Technical Dictionaries), has completed the editing of this new dictionary after years of work, in which engineering organizations, important industrial companies and large business houses and institutions of learning have cooperated. In fact, Dr. Schlomann was requested to do this work by the Assembly of German Scientific and Engineering Societies, as well as by numerous industrial organizations in Germany and other countries. His wide experience and the cooperation he has received have made it possible to produce a work containing the combined technical knowledge of a great many authorities.

In every industry many idioms or colloquial terms are used that are not included in any ordinary dictionary. The work of the translator is further complicated by the fact that there is considerable variation in many of these special terms as applied to a given process, material, tool, etc.; consequently, the practical value of a technical dictionary depends largely, aside from its general scope, upon the number of important colloquial terms it contains and upon the accuracy of their definitions, both in the original language and in the translations. The new Hoyer-Kreuter Technical Dictionary is an outstanding achievement in this respect, due, in part, to the cooperation received from engineering societies and manufacturers.

Under-Cutting in Welding

MACHINERY'S Data Sheet No. 223, April, 1932, shows a weld stated to be of correct shape and size, which has a notch or under-cut. In our practice, we do not permit under-cutting and do not believe that it is good practice. The perfect weld should have the contour of a properly designed fillet, such as would be made on a casting. This fillet can be closely approximated by tilting the structure to be welded and using a relatively high welding heat.

ROBERT E. KINKEAD

* * *

Industrial Machinery Exports

Exports of industrial machinery from the United States during February amounted to approximately $6,000,000—an advance of over 20 per cent as compared with January, but a decline of over 50 per cent as compared with a year ago. The exports of metal-working machinery amounted to $1,570,000 in February—an advance of over 50 per cent as compared with January. The outstanding items of exports were grinding machines, lathes, milling machines, forging machines, and boring mills.

Soviet Industry in 1931

In a review of Soviet industry in 1931, published in the *Economic Review of the Soviet Union*, it is mentioned that among the new plants completed last year in Russia were two plants for the building of machine tools. One of these, located at Moscow, is stated to have an annual capacity of 6200 screw machines, while the Nizhni Novgorod plant is intended for an annual production of 12,500 milling machines. Other large plants completed last year were intended for the building of automobiles, trucks, and tractors, the Nizhni Novgorod automobile plant having an annual capacity of 140,000 cars, while the Amo plant in Moscow is expected to turn out 30,000 trucks annually. The capacity of the Kharkov tractor works is 50,000 a year.

The difficulties met with in operating the Stalingrad tractor plant, which were overcome last year, have served as a warning against similar trouble in the early months of operation of other new plants. Thus, the Kharkov plant, which began operations last October, was able to produce 50 tractors a day after four months of operation, whereas it took the Stalingrad plant ten months to reach this rate of output.

According to the same report, the value of machine tools manufactured last year was 55,000,000 rubles (approximately $27,000,000). The output of high-grade cutting and measuring tools and instruments was valued at 31,700,000 rubles (approximately $15,000,000). Two new tool plants with a combined annual production capacity of 110,000,000 rubles (slightly over $50,000,000) will start operations in Moscow this year.

* * *

A Word of Encouragement

It is encouraging to note that certain branches of the machinery industry report activity. We are informed that the H. A. Smith Machine Co., Hopewell, N. J., manufacturer of gas, water, and electric meter registers, special clockwork, accurate small gears and pinions, screw machine products, sheet-metal stampings, spring motors, parts, and fittings, is operating its plant full time and has just purchased $30,000 worth of new automatic machinery.

* * *

George P. Torrence, president of the Link-Belt Co., Chicago, Ill., on April 14, addressed the Cincinnati Section of the American Society of Mechanical Engineers on the subject "Material Handling Machinery in 1932." In this paper, Mr. Torrence emphasized the value of up-to-date material-handling equipment in reducing costs to meet present prices.

THE No. 1 STANDARD VERTICAL

a New Brown & Sharpe "Standard"

—motor driven with advanced operating features

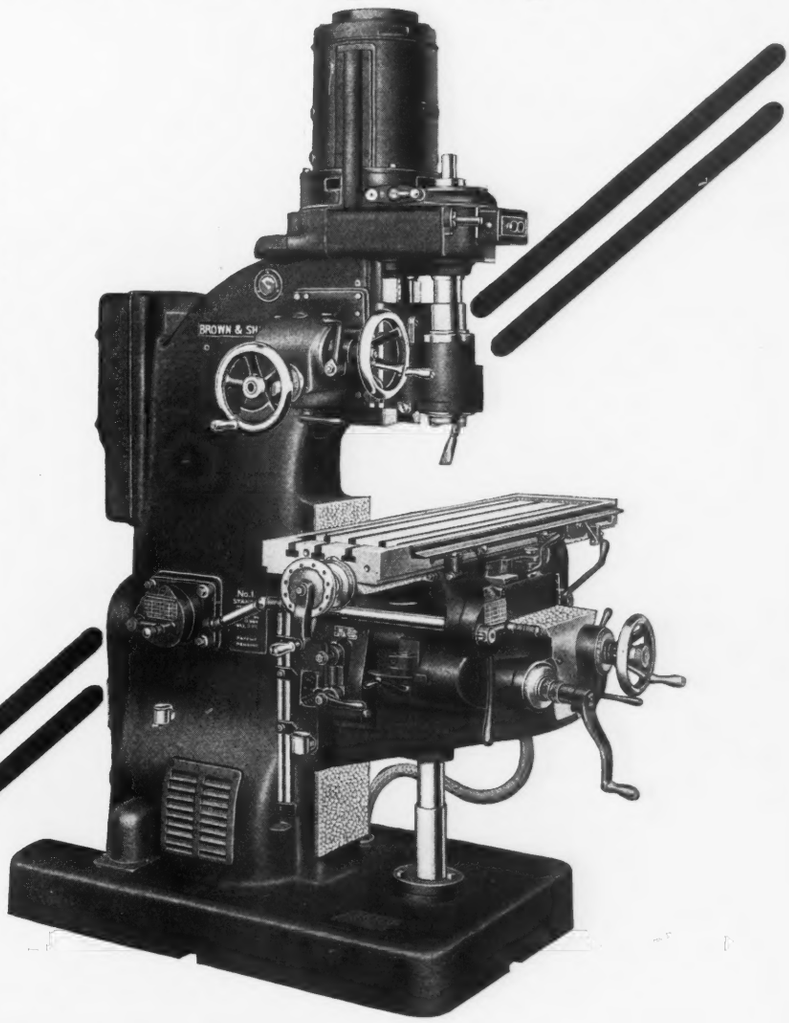
Spindle speeds 150-1800 R.P.M., in either direction. High speed series gives correct speeds when using small end mills and the new cutting alloys, tungsten carbide, etc., while the back gear range to 450 R.P.M., gives a smooth powerful drive when using larger cutters.

A new type of motorization provided through individual motor drive for spindle and individual motor drive for table and spindle feed.

Both motors controlled from single push button station accessible from front and rear operating position. Electrical controls and wiring completely enclosed.

Full control of all cutting movements and speed and feed changes from front and rear operating positions.

Power feed and fast hand adjustment for the spindle head, power fast table travel in all directions available at all times, which reduces time between cuts, and many other features of the "Standard Line" are included in the new machine. A twelve page feature specification sent on request.



MEETS THE DEMANDS OF MODERN METAL CUTTING

THE NO. 1 STANDARD VERTICAL SPINDLE MILLING MACHINE (MOTOR DRIVEN) provides a fast, sensitive machine for end mills and shell end mills from 1/8" to 3" in diameter when cutting with High Speed Steel Cutters. It is particularly fitted for mould milling, die sinking, boring and general tool room operation as well as jobbing and manufacturing within its capacity.

CAPACITY:

Longitudinal Feed, 22"
Transverse Feed, 10"
Vertical Feed of Knee, 14" } **AUTOMATIC**
Vertical Feed of Spindle Head, 4"

BROWN & SHARPE

BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

News of the Industry

LINCOLN ELECTRIC CO., Cleveland, Ohio, has appointed La Consolidada, S. A., of Mexico, distributor of the "Stable-Arc" welders and "Linc-Weld" motors in Mexico.

SAFETY GRINDING WHEEL & MACHINE CO., Springfield, Ohio, has moved its eastern office from 2731 W. Allegheny Ave., Philadelphia, Pa., to 1508 W. Allegheny Ave.

DINGS MAGNETIC SEPARATOR CO., Milwaukee, Wis., has appointed H. Max Lee, 114 W. 17th St., Los Angeles, Calif., sales representative for the company in southern California.

BELCHER & SCHACHT CO., formerly the LONG BEACH BLUEPRINT CO. SUPPLIES DIVISION, has been established by Ernest Belcher and Vernon C. Schacht at 237 American Ave., Long Beach, Calif.

BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa., has opened a new branch office in the Ford Bldg., Detroit, Mich. J. E. Polhemus has been appointed district sales manager in charge of the Detroit territory.

WATSON-STILLMAN CO., 107 Aldene Road, Roselle, N. J., builder of hydraulic machinery and accessories, has appointed the Spalding Machinery Co., Inc., Engineering Bldg., 205 W. Wacker Drive, Chicago, Ill., sales representative in the Chicago territory.

BARBER-COLMAN CO., Rockford, Ill., manufacturer of milling cutters, hobs, reamers, and allied machinery, has established an office in Pittsburgh, with William G. Taphorn in charge. Mr. Taphorn was formerly at the Chicago office of the company.

SIEWEK TOOL CO., 10232 Woodward Ave., Detroit, Mich., manufacturer of rapid-clamping drill jigs, box jigs, leaf jigs, and fixture locks, has opened a branch office at 173 Lafayette St., New York City, of which the F. C. Danneman Co. will have charge.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., announces that the suit between that company and the Dayton Rubber Mfg. Co., Dayton, Ohio, involving patent infringement pertaining to multiple V-belt drives has been settled out of court by a licensing agreement.

NORMA-HOFFMANN BEARINGS CORPORATION, Stamford, Conn., manufacturer of "Precision" ball, roller, and thrust bearings, announces the removal of its New York sales office from the Grand Central Terminal to larger quarters in the Commerce Bldg., 155 E. 44th St., New York City.

KRON CO., formerly the American Kron Scale Co., Bridgeport, Conn., manufacturer of industrial scales, has appointed George A. Nichols New York district manager. Mr. Nichols will be located at 801 Chrysler Bldg. He was formerly the New York district manager of the Wright Mfg. Co.

GEOMETRIC STAMPING CO., Cleveland, Ohio, has appointed E. F. Wilmot of the E. F. Wilmot Co., 62 Ridgemont St., Boston, Mass., representative of the company in the Boston district, and H. A. Bell, Third National Bank Bldg., Dayton, Ohio, representative in the Dayton-Cincinnati district.

PITTSBURGH EQUITABLE METER CO. and the MERCO NORDSTROM VALVE CO. announce that the two companies have consolidated. W. F. Rockwell, of the Pittsburgh company, becomes president of the Merco Nordstrom Valve Co., which will operate as a division of the Pittsburgh Equitable Meter Co.

TIPS, INC., 515 Cathedral St., Baltimore, Md., announces the addition of a new torch to its line of welding and cutting torches. The new torch is known as the Type NVM standard cutting and welding torch No. 960, and will cut or weld any thickness of metal within the range of the process.

ORVILLE SIMPSON CO., Cincinnati, Ohio, has appointed Cleveland Duplex Machinery, Inc., Penton Bldg., Cleveland, Ohio, representative of the company in the northwestern Ohio territory. The Cleveland organization will handle the sale and service of Simpson's Rotex screeners.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio, manufacturer of alternating- and direct-current motors, has established a sales branch at 703 Bona Allen Bldg., Atlanta, Ga., with Marshall Whitman and George Gardner in charge. The territory covered by this office will be North and South Carolina and Georgia.

REED-PRENTICE CORPORATION, Worcester, Mass., announces the election of the following officers: C. L. Stevens, president; F. W. McIntyre, general manager; C. H. Carswell, treasurer; and J. F. Richeimer, assistant treasurer. F. W. McIntyre will retain his former position as vice-president and sales manager, in addition to acting as general manager.

B. C. AMES CO., Waltham, Mass., manufacturer of micrometer dial gages and precision bench machinery, announces the removal of its Detroit branch to the Michigan Theatre Bldg., Bagley and Clifford Sts., Detroit, Mich. This office is under the supervision of Edward D. Haggerty, who has been Detroit manager since the opening of that office three years ago.

I. S. SPENCER'S SONS, INC., Guilford, Conn., manufacturers of gray-iron, brass, and bronze castings, and general hardware, are celebrating, this year, the seventy-fifth anniversary of the organization. The company was founded in 1857, making only gray-iron castings, but has since then branched out into the non-ferrous field and added many products in iron, bronze, and brass.

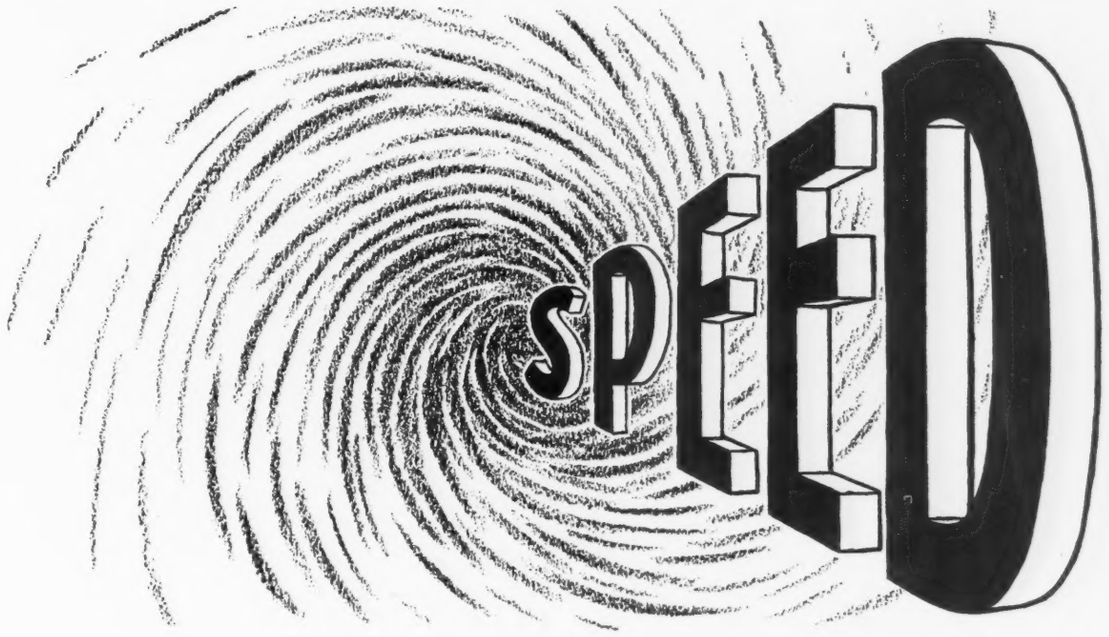
FREEMAN QUADRIVE CORPORATION announces that the company is ready to remove its factory and general offices from Detroit to Pontiac, Mich. It is expected that truck production will begin in ninety days in the new factory, located in the old Eaton Axle & Spring Co.'s plant on Branch St., Pontiac. The company has manufactured four-wheel-drive trucks for the last ten years.

HIGHLAND IRON & STEEL CO., Chicago, Ill., an associate company of the American Chain Co., Inc., announces a new development in the manufacture of wrought iron. The company produces a wrought iron alloyed with nickel, with copper, with nickel and molybdenum, and with copper and molybdenum. This development is the result of several years of research work. Both the strength and the fatigue-resisting properties of wrought iron are materially increased by alloying with the metals mentioned.

DARDELET THREADLOCK CORPORATION, 120 Broadway, New York City, has licensed the Western Screw Mfg. Co. of Chicago, Ill., and the American Screw Co. of Providence, R. I., to manufacture and sell bolts, nuts, and screws threaded with the Dardelet self-locking thread. The Holo-Krome Screw Corporation, Hartford, Conn., has also been licensed to manufacture and sell socket-head cap-screws, hollow set-screws and countersunk pipe plugs threaded with the Dardelet self-locking thread. The Gifford Screw Products Co. of Worcester, Mass., has been licensed to manufacture and sell special screw machine products with the Dardelet self-locking thread.

EISLER ELECTRIC CORPORATION, 769 S. 13th St., Newark, N. J., manufacturer of electric welding machinery, incandescent lamp equipment, electric furnaces, glass-working machinery, and many other types of special equipment, announces that the company is prepared to take in hand the development of new inventions and devices. The company is prepared to render such service in the mechanical, electrical, or metallurgical field, and has facilities for the commercial production, as well as the merchandising, of products within the engineering branches mentioned. Designs are produced from basic ideas, and machines to produce inventions in a commercial way are also designed and constructed.

Improved cutting tools demand



in a rigid spindle...

Fast and slow speeds with one positioning at any height within the range of the machine, are obtained through

THE IDEAL DRIVE

available only in the latest

LUCAS

"PRECISION" Horizontal Boring,
Drilling and Milling Machines

... HAVING COMPLETE SPEED RANGES

13 1/2 to 1200 R.P.M. for the 3 inch spindle No. 41 Machine.
9 to 1000 R.P.M. for the 4 inch spindle No. 42 Machine.
7 1/2 to 860 R.P.M. for 5 inch spindle Nos. 43 and 53 Machines.

NOW YOU CAN

Bore and Mill Cast Iron at cutting speeds as high as 300 ft. per minute with Tungsten Carbide Cutters

Mill Aluminum at 800 to 1000 ft. per minute with a feed as high as 80 in. per minute.

Drill as small as 1/4" efficiently at 80 ft. per minute cutting speed with feeds from .002" per revolution to as coarse as the drill will stand.

YOU CANNOT COMPETE WITHOUT THIS MODERN MACHINE

THE LUCAS MACHINE TOOL CO., Cleveland, O.

Coming Events

MAY 3—Mid-year meeting of the Gray Iron Institute in Detroit, Mich.; headquarters, Hotel Statler. Institute manager, Arthur J. Tuscany, 4300 Euclid Ave., Cleveland, Ohio.

MAY 3-5—Annual convention of the American Foundrymen's Association to be held at the Hotel Statler, Detroit, Mich. Executive secretary, 222 W. Adams St., Chicago, Ill.

MAY 4-5 — Management, Maintenance and Materials Handling Meeting of the American Society of Mechanical Engineers, at the Hotel Statler, Detroit, Mich. This meeting was formerly planned to be held in Philadelphia, but the Philadelphia meeting has been cancelled.

MAY 10-28—Fourth International Patent Exposition to be held at the Grand Central Palace, New York City. Herman Larson, managing director, Grand Central Palace, New York.

MAY 12-13—Sixteenth annual meeting of the American Gear Manufacturers' Association to be held at the Hotel Statler, Cleveland, Ohio. The Executive Committee will meet at the same place, May 11. T. W. Owen, secretary, Ninth-Vincent Bldg., Cleveland, Ohio.

MAY 18—Spring Meeting of the Steel Foundcrs' Society of America, at the Hotel Roosevelt, New York City. G. P. Rogers, managing director, 932 Graybar Bldg., New York City.

JUNE 3-4—Ninth annual convention of the National Association of Foremen to be held at Mansfield, Ohio. E. H. Tingley, secretary, Refiners Bldg., Dayton, Ohio.

JUNE 12-17—Spring meeting of the Society of Automotive Engineers, at White Sulphur Springs, W. Va. John A. C. Warner, secretary, 29 W. 39th St., New York City.

JUNE 20-24—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. C. L. Warwick, secretary, 1315 Spruce St., Philadelphia, Pa.

JUNE 23-24—Annual meeting of the Mechanical Division of the American Railway Association in Chicago, Ill.; headquarters, Congress Hotel. This will be strictly a business meeting with no exhibits. Secretary, V. R. Hawthorne, 59 E. Van Buren St., Chicago, Ill.

JUNE 27-30 — Semi-annual meeting of the American Society of Mechanical Engineers, jointly with the Canadian Institute of Engineers, at the Bigwin Hotel, Lake of Bays, Highlands of Ontario, Canada. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

OCTOBER 3-7 — National Metal Congress, Buffalo, N. Y., sponsored by the American Society for Steel Treating, 7016 Euclid Ave., Cleveland, Ohio, with the cooperation of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Welding Society, and the Wire Association.

OCTOBER 3-8—Fourteenth annual National Metal Exposition to be held in the 174th Regiment Armory, Buffalo, N. Y. W. H. Eisenman, secretary, American Society for Steel Treating, 7016 Euclid Ave., Cleveland, Ohio.

New Books and Publications

TESTS OF JOINTS IN WIDE PLATES. 74 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 239 of the Engineering Experiment Station. Price, 40 cents.

THE USEFULNESS OF MATHEMATICS TO ENGINEERS. By P. W. Ott. 16 pages, 6 by 9 inches. Published by the Ohio State University, Columbus, Ohio, as Circular No. 27 of the Engineering Experiment Station.

THE STORY OF NICKEL. By William H. Baldwin, Public Relations Counsel to the International Nickel Co., Inc. 44 pages, 6 by 9 inches. Published by the International Nickel Co., Inc., 67 Wall St., New York City.

SAFETY CODES FOR THE PREVENTION OF DUST EXPLOSIONS. 87 pages, 6 by 9 inches. Published by the United States Department of Labor, Washington, D. C., as Bulletin No. 562 of the Bureau of Labor Statistics. Price, 15 cents.

THERMAL EXPANSION OF HEAT-RESISTING ALLOYS, NICKEL-CHROMIUM, IRON-CHROMIUM, AND NICKEL-CHROMIUM-IRON ALLOYS. By Peter Hidnert. 36 pages, 6 by 9 inches. Published by the United States Department of Commerce, Washington, D. C., as Research Paper No. 388 of the Bureau of Standards. Price, 25 cents.

MATERIALS CONTROL. 16 pages, 8½ by 11 pages. Published by the Policyholders' Service Bureau of the Metropolitan Life Insurance Co., 1 Madison Ave., New York City.

This report has been prepared by the Metropolitan Life Insurance Co.'s Service on Manufactures for the purpose of illustrating the general procedure followed in connection with the important phase of plant management that may be classified as materials control. The report does not aim to give a detailed plan suitable for installation, but rather presents a summary of typical practice.

UNEMPLOYMENT BENEFIT PLANS. By the Committee on Industrial Relations, National Metal Trades Association; G. E. Randles, chairman. 14 pages, 6 by 9 inches. Published by National Metal Trades Association, Peoples Gas Bldg., Chicago, Ill.

This booklet contains a brief but comprehensive review of the unemployment benefit plans that have been put in effect, both by governments, as in England and Germany, and by private firms, as in the United States. The analysis presented of the plans of twenty American companies for unemployment insurance is of particular interest, as these plans now affect over 100,000 workers.

AMERICAN MACHINISTS' HANDBOOK. By Fred H. Colvin and Frank A. Stanley. 1134 pages, 4 by 7 inches. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $4.

This is the fifth edition of a reference book of machine shop and drawing-room data, methods, and definitions. The present edition has been brought out in order to incorporate changes in shop practice and shop standards that have taken place since the last edition was published in 1926. Although considerable new material has been added, the number of pages is not much greater than in previous editions, many pages of the last edition having been omitted owing to the fact that improved tools and methods have made the previous matter obsolete.

HOW TO RUN A LATHE. 160 pages, 5 by 8 inches. Published by the South Bend Lathe Works, 426 E. Madison St., South Bend, Ind. Price. 25 cents.

This is the thirtieth edition of an authoritative manual on machine shop work, particularly on the care and operation of a modern screw cutting lathe. The book is illustrated with many set-ups showing the latest shop methods for handling lathe jobs. Among the material added in the present edition is a section on blueprints for the shop, covering jobs in the machine shop, home shop, automotive servicing shop, and the school shop. Other additions include information on motorized service shops; hints on grinding lathe tools; information on the use of small lathes; and explanations of various motor drives for lathe equipment.

HEAT ENGINES. By S. H. Moorfield and H. H. Winstanley. 287 pages, 5 by 7½ inches. Published by Longmans, Green & Co., 55 Fifth Ave., New York City. Price, $2.25.

The object of this work, as stated in the preface, is to provide a self-contained course in heat engines for students who desire to become mechanical engineers. It is expected that the reader will have obtained some previous elementary knowledge of this subject, but the book is intended to provide a suitable first-year course in heat engines. No attempt has been made to give detailed instructions for experimental work, since this depends so much upon the equipment available. Mere descriptions of equipment and machinery have been avoided to allow for a clear and concise presentation of the essential principles of heat engines. Only such descriptions, therefore, as are necessary to the development of the theory are included. Examples are given at the end of the chapters to amplify the text.

THE WAY OUT. By Charles R. Stevenson. 44 pages, 6 by 9 inches. Published by Stevenson, Jordan & Harrison, 19 W. 44th St., New York City. Price, 25 cents.

In investigating the causes of our economic difficulties, the engineer, as a rule, does not display the same open-mindedness that he shows in attacking engineering problems. When it comes to economics, even the engineer appears to be too much tied to tradition. He fears to examine too critically the commercial and economic practices of the past; and so he often fails to see clearly that which, were he dealing with an engineering subject he would consider obvious.

In view of this, it is stimulating to read the logical, clear-cut presentation that the author makes in the book under review. He first outlines what he considers to be the fundamental objectives of industrial America, and then draws a picture of the present conditions and how they were brought about. Up to this point, there is practically no chance for any difference of opinion. The remedy that he proposes, however, will be questioned by many; but it is so logically presented that it is at least worthy of serious thought. It will not do to simply dismiss it without proposing something better.

The author does not believe that the proposals he makes will be immediately accepted or adopted; but any proposal that will stimulate discussion is well worth the attention of serious-minded engineers and business men. The book is quickly read, and everyone interested in our present economic problems ought to read it.

A 7-in. AJAX MACHINE FORGING

by the

AMERICAN FORGE COMPANY

Chicago, Ill.

•

THIS 70-pound tractor flange is a fine example of present-day progress in upset forging.

It is forged without waste in flash or tong hold by the American Forge Company on one of their seven *AJAX 7-in. Forging Machines.* In shape and dimensions it conforms closely to the finished piece, limiting waste in machining to a minimum.

In the production of large forgings especially, great economies can be effected in both material and machining through the use of *AJAX Heavy Duty Upsetting Forging Machines.*

THE AJAX MANUFACTURING CO.
EUCLID BRANCH P. O., CLEVELAND, O.
Chicago Office: 621 Marquette Bldg.

AJAX

New Catalogues and Circulars

CAST-IRON PULLEYS. T. B. Wood's Sons Co., Chambersburg, Pa. Circular outlining the advantages of Wood's cast-iron pulleys.

LEATHER BELTING. J. E. Rhoads & Sons, 35 N. 6th St., Philadelphia, Pa. Folder containing data on Rhoads Tannate special rounded belts.

MACHINE TOOLS. Eastern Machinery Co., 3267 Spring Grove Ave., Cincinnati, Ohio. List No. 32 of the rebuilt machine tools that this company carries in stock.

HYDRO-PNEUMATIC ACCUMULATORS. John Robertson Co., 123 Water St., Brooklyn, N. Y. Circular illustrating and describing the Robertson hydro-pneumatic accumulator.

WELDING EQUIPMENT. Lincoln Electric Co., Cleveland, Ohio. Application Sheet No. 28 in a series on the elements of design, discussing welded construction as applied to levers.

ELECTRIC MEASURING INSTRUMENTS. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Catalogue 40, containing data on apparatus for electrical resistance measurements.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Loose-leaf circular No. 198-FE, illustrating the application of the New Departure double-row ball bearings in live center design.

SCALES. Kron Co., Bridgeport, Conn. Booklet entitled "Scale-ology," dealing with the subject of scientific automatic weighing, and showing a few of the many types of Kron automatic scales.

LUBRICANTS. Acheson Oildag Co., Port Huron, Mich. Technical bulletin No. 113-3, containing information on the importance of colloidal graphite lubricants in running-in operations.

ELECTRIC CONTROLLING EQUIPMENT. Monitor Controller Co., Baltimore, Md. Bulletin describing the outstanding features of a new Monitor accelerator for starting direct-current motors.

MILLING AND BORING MACHINES. Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating and describing Ingersoll open-side milling and boring machines built to meet special requirements.

DRILL FIXTURES. Modern Engineering Service, 7 E. Grand Ave., Detroit, Mich. Folder containing drawings and tables of dimensions and prices for Modern drill fixtures of the two-post and four-post types.

CIRCUIT-BREAKERS. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Bulletin C-1937, on Type AB "De-ion" circuit-breakers. Bulletin C-1939, on new revolutionary low-voltage circuit protection.

CLUTCHES. Conway Clutch Co., 1547 Queen City Ave., Cincinnati, Ohio. Bulletin K-32, containing complete tabulated data, including dimensions, capacity, and prices of Conway one-revolution clutches.

SHEET-METAL WORKING MACHINES. Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y. Bulletin 71-D, descriptive of power squaring shears with capacities for soft steel of No. 14 gage and lighter.

INDUSTRIAL COMPOUNDS. Technical Products Co., Pittsburgh, Pa. Catalogue 32, containing information on "Insa-lute" adhesive cement and industrial compounds for acidproofing, surface-coating, impregnating, sealing, insulating, etc.

MATERIALS-HANDLING EQUIPMENT. Cleveland Electric Tramrail Division of the Cleveland Crane & Engineering Co., Wickliffe, Ohio. Circular illustrating the application of the Cleveland overhead tramrail system in the automotive industry.

INDICATING AND RECORDING INSTRUMENTS. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y. Catalogue 1025, descriptive of a new all-metal automatic flue gas analyzer known as the Tag-Mono indicator-recorder.

DRILL GRINDING MACHINES. William Sellers & Co., Inc., Philadelphia, Pa. Bulletin entitled "Common Causes of High Drilling Costs," emphasizing the importance of correctly ground drills and illustrating the Sellers drill grinding machine.

SHOP TRUCKS. Tidy Products, Inc., Chrysler Bldg., New York City. Circular illustrating and describing the new "Truly Safe" tilt trucks brought out by the company for handling barrels containing oils, paints, chemicals, etc., in industrial plants.

OILSTONES AND SHARPENING STONES. Pike Mfg. Co., Pike, N. H. Circular illustrating Pike powered oilstones and examples of their many applications for tool sharpening. Circular showing various types of oilstones and giving dimensions and price lists.

TESTING MACHINES. Baldwin-Southwark Corporation, Philadelphia, Pa. Bulletin 28, descriptive of Southwark-Emery universal hydraulic testing machines. The special features of these machines are pointed out, and the various sizes are illustrated and described.

WEAR AND LUBRICANT TESTING MACHINE. Timken Roller Bearing Co., Canton, Ohio. Circular announcing the Timken wear and lubricant tester for measuring friction and for testing the load-carrying capacity of lubricants and the wear and durability of all kinds of materials.

OIL SEALS. Aetna Ball Bearing Mfg. Co., 4600 Schubert Ave., Chicago, Ill. Circular describing the features and application of the Aetna oil seal, which is designed to eliminate leakage of oil, grease, water, and other liquids along shafts, and to keep dirt, grit, and water out of bearings.

HACKSAW-BLADE RECLAIMING MACHINE. L & L Mfg. Co., 54 Springdale Ave., East Orange, N. J. Circular descriptive of the new "Elenel" reclaimer, a machine for reclaiming high-speed steel machine saw blades. The circular gives definite figures of savings effected by this process.

LEATHER BELTING. Chas. A. Schieren Co., 30 Ferry St., New York City. Circular entitled "Doing One Job and Doing it Well," outlining some of the requirements for high-grade leather belting and describing the control tests made by this company to insure high quality in the finished product.

PORTABLE AIR COMPRESSORS. Worthington Pump & Machinery Corporation, Harrison, N. J. Bulletin W-850-B5, showing the mechanical features of the line of portable air compressors made by this concern, as well as mountings on trailers, trucks, tractors, railroad cars, mine cars, and wooden skids.

HEAT-TREATING FURNACES. W. S. Rockwell Co., 50 Church St., New York City. Catalogue 329, illustrating applications of Rockwell continuous furnaces of the pusher type. Two pages of line illustrations show some of the many designs developed to meet different requirements of heating, cooling, and handling.

SILENT CHAINS AND SPROCKETS. Whitney Mfg. Co., Hartford, Conn. Catalogue V-100, containing descriptive material and tabulated data covering the Whitney line of silent chains and sprockets. The engineering data section of the catalogue contains information on the proper selection and design of silent chain drives.

MATERIALS-HANDLING EQUIPMENT. Cleveland Electric Tramrail Division of the Cleveland Crane & Engineering Co., Wickliffe, Ohio. Circular entitled "Some Things are Hard to Believe," telling the story of how, within three years, ox carts have been replaced by modern mechanical equipment in a large factory, for moving materials and product.

POWER HAMMERS. Nazel Engineering & Machine Works, 4047 N. 5th St., Philadelphia, Pa. Circular entitled "Endorsed by Over 1050 Firms in 66 Different Industries—There Must be a Reason," illustrating the Nazel motor-driven hammer, and outlining the advantages of this machine for mass production, commercial forging, or maintenance work.

ELECTRIC EQUIPMENT. General Electric Co., Schenectady, N. Y. Circulars GEA-19G, 1565, 1580, 1587, and 1588, illustrating and describing, respectively, magnetic switches for alternating-current motors; magnetic reversing switches; single-speed induction motors for elevator service; combination magnetic switches; and explosion-proof magnetic switches.

Societies, Schools and Colleges

DREXEL INSTITUTE, 32nd and Chestnut Sts., Philadelphia, Pa. Catalogue for 1932-1933, containing calendar and outline of courses.

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y. Catalogue for 1932, containing calendar, outline of courses, lists of graduates, etc.

POLYTECHNIC INSTITUTE OF BROOKLYN, 99 Livingston St., Brooklyn, N. Y. Seventy-seventh annual catalogue, containing an outline of the courses offered at the day session of the Institute.

COLUMBIA UNIVERSITY, Morningside Heights, New York City. Report of comparative load-displacement tests on lap joints assembled with Dardelet rivet bolts and hot-driven rivets, made for the Dardelet Threadlock Corporation, 120 Broadway, New York City, by the Testing Laboratories of the Department of Civil Engineering of the university.